

C. B.

*Philosophical Principles*  
O F  
**M E D I C I N E,**  
In THREE PARTS.

CONTAINING,

- I. A Demonstration of the general LAWS of GRAVITY, with their Effects upon Animal Bodys.
- II. The more particular LAWS which obtain in the Motion and Secretion of the vital Fluids, applied to the principal Diseases and Irregularitys of the Animal Machine.
- III. The primary and chief Intentions of Medicine in the Cure of Diseases, problematically propos'd and mechanically resolv'd.

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By THO. MORGAN, M.D.

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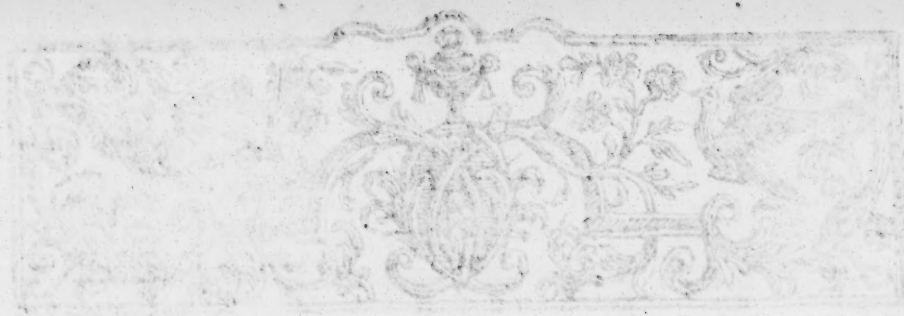
The SECOND EDITION, with large Additions relating to the Nature and Manner of Animal Secretions in general, with a particular regard to the Urinary Evacuations; in which the *Bellinian* Hypothesis of Secretion is shewn to be false and absurd, as inconsistent with the Appearances of Nature, and all the Laws of Animal Motion.

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L O N D O N :

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To the most Honoured

Sir *HANS SLOAN* Bar.  
President of the Royal Col-  
lege of Physicians in *Lon-*  
*don*; and the rest of the  
much Honoured Members  
of that SOCIETY.

Most and much Honoured,

 *THE Motive of a Dedication*  
is commonly either Gratitude  
or Interest, and very often  
both Accounts are prudently  
summ'd up in one; and the Author  
with great Modesty desires, that what  
he offers may be taken in part of Pay-  
ment for Favours already receiv'd, and  
at the same time be look'd upon as a

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*valuable Consideration for those that are yet behind.*

*FOR my own part, I design this Address neither as a Debt nor a Petition ; but as a fair and equitable Appeal to you who are the proper Judges, whether this way of treating the Subject, is likely to be of any real Use or Advantage in the Theory and Practice of Medicine.*

*BUT whatever the Merits of the Cause be, the Equity and Fairness of the Appeal must certainly be allow'd ; for as I can herein claim no benefit from the Honour of any particular personal Acquaintance or Friendship, so I desire no better Protection against malevolent Censure : and thus far I am secure, under the Patronage of the most learned and illustrious Body of Physicians in the World ; since, upon this foot, to beg your Favour, would be in effect to impeach your Justice.*

YOU

## DEDICATION. V

*YOU* are sufficiently sensible that no Improvement of any sort can be made, where a rational freedom of Inquiry is deny'd; and I cannot but mention here, what redounds so much to your Honour, that you have ever acted upon this noble and generous Principle. You have the Health and Ease, the Lives and Happiness of your fellow Creatures too near at heart, to sacrifice those valuable Interests to any darling Hypothesis, indisputably receiv'd, and establish'd into a System of Physical Orthodoxy.

'TIS from this liberty of reasoning, and a right application of it, that Medicine begins now to arise out of its antient Chaos, and from the Advancements already made to give us the promising Hopes of its appearing some time or other as a real SCIENCE. 'Tis from hence that this excellent and useful Subject has of late Years been rescu'd in great measure from the violent Hands of chymical and metaphysi-

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*cal Empyricism; by which every thing was explain'd into Darknefs, and the Knowledge of the Disease lost in the mysterious Disquisition of the Cause.*

*IF I have here contributed any thing towards the setting this most necessary part of natural Philosophy in a clearer Light, or towards the engaging some abler Pen to undertake a more complete Work of the same kind, my Design in it will be sufficiently answer'd: But if I should unhappily fail of any such Success, I doubt not but you will at least pardon the freedom of the Attempt, in consequence of the goodness of the Intention. I am,*

GENTLEMEN,

*Your most Obedient*

*Humble Servant,*

Tho. Morgan.



T H E

# P R E F A C E.



*ENS sana in corpore sano*, is a short but full Description of human Felicity, or of the Happiness of Man as he is a Creature compounded of Soul and Body. And next to the Knowledge of God, of our Duty to him, and the means of obtaining the divine Favour; the Knowledge of the Principles and Laws of Motion, as applied to the Structure and Operations of the animal Body, in order to prevent or remove the Diseases and Irregularitys to which it is liable, and maintain it in as sound and uninterrupted a *state of Health* as possible, is doubtless the most excellent and useful.

THAT the animal Body is a pure Machine, and that all its Operations and Phænomena, with the several changes which happen to it, are the necessary result of its Organization and Structure, is now generally known, and confirmed beyond all contradiction by

the modern Observations and Improvements in Anatomy.

THE Life of an Animal, as far as it falls under a medical Consideration, consists in the Circulation of the Blood; and Death is nothing else but a Cessation of that Motion, or a Stagnation of the animal Fluids. Health is the uniform Circulation of the Blood, and the consequent Derivation of the several Liquors secreted by the Glands, in their natural and due Proportions: and any irregularity of excess or defect herein, induces some Sickness or Disease. Such is the surprizing minuteness and nice adjustment of the numberless Springs and Movements upon which Life depends; and so many the Irregularitys to which every one of them is liable, that the Preservation of this curious piece of Machinery, and the continuance of its Operations and Functions for three or fourscore Years together, is little less than a Miracle: at least, every one must allow it as a convincing Proof of the inimitable Wisdom and Contrivance of its Author and Former.

AND here I must observe, what one cannot reflect upon without wonder; That the animal *Automaton* is contriv'd and adjusted upon Principles of Self-preservation: 'tis form'd and design'd for the helping itself, and laid under a sort of mechanical necessity of regulating its own Motions. There is no Disorder which happens to it, but there is at the same time a considerable effort of Nature,

*i. e.*

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*i. e.* of the Machine, to rectify the Error, and restore the soundness of its Constitution. And herein this noble Machine of an animated Body, which is the perfect Workmanship of Almighty God, differs from the most finish'd Pieces of Art, and every thing of human Contrivance ; since in the most complete and admired Productions of this latter kind, there is not the least appearance, no traces or footsteps of this self-preserving or self-restoring Principle to be found. Any Irregularitys happening to a Clock, a Watch, or other piece of Mechanism, which is the result of Art and human Contrivance, must necessarily continue, and disturb the Motions of the whole, till it be set right by the Hand and Skill of the Artist. There is no power or tendency in the Machine to restore or rectify itself ; and 'tis impossible, for instance, that a Disorder or Defect in the Pendulum should be rectify'd or adjusted by the Motion of any other part. But the animal Machine is contriv'd and adjusted with such a wonderful harmony and connexion of its several Organs and Functions, that an irregular or diseased Motion in one part, necessarily excites such Motions in other parts, as tend to rectify the first Disorder, and set all right in a natural way, without any foreign extrinsic aid or assistance from Art. This natural necessary *Conatus* or Effort in the animal Machine towards Health and Rectitude, is sufficiently evident in fact, being a matter of common  
Obser-

Observation and Experience which no body can deny. Every one talks of Nature's helping itself, and of the efforts or endeavours of Nature to throw off the Disease; but the Grounds and Principles of this, how it happens, or by what Mechanism and Contrivance it is brought about, have not been enough, and can never be too much consider'd by the Physicians. To set this part of the animal Oeconomy in a clearer Light, is partly the design of the following Propositions; but all the use I shall make of it here, is to observe how necessary it is for a Physician to be well acquainted with the Principles and Laws of Motion, together with the Constitution and Structure of animal Bodys, and the application of one to the other. For since the animal Body is a Machine, and Diseases are nothing else but its particular Irregularitys, Defects and Disorders, a blind Man might as well pretend to regulate a piece of Clock-work, or a deaf Man to tune an Organ, as a Person ignorant of Mathematicks and Mechanism to cure Diseases, without understanding the natural Organization, Structure, and Operations of the Machine which he undertakes to regulate.

As there are two things necessary to constitute a good Philosopher, namely, a just acquaintance with the Phænomena of Nature, grounded upon accurate Observations and Experiments, and a competent skill in Arithmetick, Geometry and Algebra, to enable him

to

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to reduce the Forces and Operations of Bodys to a *Calculus*, in order to find out the adequation and proportion between the natural Causes and their Effects: so the like Mathematical and Mechanical Reasoning, join'd with the History of Diseases, their Symptoms and Cure, drawn from Experience, are both necessary in Physicians, and one without the other is altogether insufficient. It is a little surprizing therefore to hear some Gentlemen of the Faculty declaim against Mathematical and Mechanical Theorys *in Re Medica*, since this is in effect to maintain, that Medicine is grounded upon no Principle at all; that if Diseases are cured, it must be by chance; and that consequently there is no difference but that of a *Diploma* between a Physician and a Quack. 'Tis evident to all experience, that new Species of Diseases, or new Symptoms attending the same Diseases, daily arise and offer themselves in the Practice of every Physician, in which the Historys of Diseases can be of little use: and in this case, where Experience fails, as it will in a thousand Instances, every one, how much soever he may declaim against Theorys, presently recurs to his own Theory, such as it is, true or false, right or wrong, and accordingly attempts the Cure at least for Experiment's sake; and so the Patient often pays dear for what the Doctor decrys only because he does not understand. But I must do our Physicians the justice to own, that they now seem  
pretty

pretty generally disposed to abandon Mystery for plain Sense, and to substitute demonstrative and experimental Truths, in the room of unintelligible Terms, occult Qualitys, precarious Hypotheses, and that infinite jumble of chymical and metaphysical Jargon, which had a long time passed for the *Rationale* of Medicine. A moderate skill in the Mathematicks, and a tolerable acquaintance with the mechanical Powers, begin to be reckon'd a necessary Qualification for one who would make a figure in his Profession : and 'tis to be hoped, that this, in time, will come to be allow'd as the true Characteristick of a rational Physician, as distinguish'd from an Empyrick. And indeed, since it is the business of a Physician to assist Nature in its Operations under the most nice and difficult Circumstances, it is impossible he should acquit himself herein with satisfaction and success, or act otherwise than at blind random, if he has not the skill of applying, as occasion serves, mathematical Quantitys and Proportions to the mechanical Powers; upon which all the Laws of the animal Oeconomy, and the Effects and Consequences of Motion in the mutual Action and Re-action of Bodys, entirely depend.

F A L S E Principles of Reason, and a wrong application of Experiments, have for a long time past effectually darken'd and obscured the real State of Physick and Diseases; while Men overlooking and neglecting the most ob-

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obvious and sensible Phænomena, have pretended to search into the deep *Recondita* and Recesses of Nature, and explain every thing by Causes either wholly imaginary and unintelligible, or which at least if granted and ever so well understood, could have no manner of relation to the Cure of Diseases: and herein the Gentlemen of the chymical Pharmacy must be allow'd to have had their share; who, fired with the Expectation of the *Philosopher's Stone*, and inflated with the vain Conceit of a miraculous Power, have been generally Men of strong Imaginations and weak Judgments; and accordingly the Experiments they have given us concerning the Blood and animal Liquors, rather shew what Changes and Alterations may be induced and made upon them by the Force and violent Action of Fire, than what their natural Constitution, Textures, and Uses are. Is it not surprizing to see a Man turn the animated Body into a chymical Furnace, and attempt to explain all the Phænomena of animal Motion by the mutual Struggles, Fermentations, and Effervescences of Acids and Alcalys? as if the animal System was a mere Laboratory, and the Nerves and Blood-Vessels fill'd with *Aqua fortis* and *Spirit of Wine*. The animal Spirits have been introduc'd and discours'd of as intelligent free Agents, and there is nothing that has been thought difficult to account for in the whole animal Oeconomy, but what has been attributed to the miraculous

lous Power and Operations of these Spirits: when they are pleas'd and in good temper, they are the pacifick Agents and Emissarys of the Soul, they keep all quiet and right within, and bless the animal Kingdom with a chearing, invigorating Warmth and vital Sunshine; on the other hand, they are no sooner disturb'd, enrag'd, and put out of humour, but they presently declare War, and execute their Vengeance by shaking the very Foundations of Nature, and throwing the whole animal Fabrick into Confusion. In a word, the Spirits are call'd up upon all occasions, and employ'd about every thing but what they are capable of effecting; while the obvious sensible Qualitys of the nervous Fluid, and the Purposes to which it serves in the animated Body, have been altogether overlook'd or misunderstood.

THIS pneumatical Contrivance, for explaining every thing by the inexplicable Motion of the Spirits, is not much mended in the *Atomical* or *Corpuscularian Hypothesis*; by which others have attempted to found the *Rationale* of Diseases and their Symptoms, in the supposed and barely imaginary Texture and Constitution of the morbidick Matter. Should I here recount all that has been advanc'd in this way, under an appearance and shew of Mechanism, it might serve perhaps agreeably to entertain the Reader, but could give him no light into the nature of Diseases, or the method of curing them. Did

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we understand the internal Texture and Constitution of the Blood and animal Fluids, as exactly as we do the Propertys of a Triangle; and could we examine every Particle in it with our Microscope, thro' all the infinite Divisions of which Matter is capable; this might doubtless furnish us with an infinite number of very curious and delightful Speculations, but perhaps would contribute very little to the cure of Diseases, which must depend not upon the Texture and Constitution of the extremely minute and insensible parts of the Blood, but upon its sensible Qualitys and Effects, as it is liable to the same Laws of Motion with all other mix'd and heterogeneous Fluids.

IF the Liver, for instance, is obstructed, it can be of little consequence to the Physician to know the Nature and Constitution of the obstructing Matter, as whether it be Salt or Sulphur, Soap or Tartar, an Acid or an Alcaly. He may imagine in this case what pleases him best, but the Cure will be the same, if the natural Force or *Momentum Motus* of the Blood assisted by Medicine, be capable of removing the Obstruction. The Knowledge of the Organization and Structure of the animated Body, together with the Forces, Velocitys, Quantitys, and different Determinations of Motion in the circulating Fluids, while they are in their natural State; with such particular Alterations in all or any of these as constitute this or the other Disease;

ease ; is beyond all doubt a Matter of vastly greater consequence than the Dissection of Atoms, or an intricate useless Inquiry concerning the Texture and Cohesion of certain minute and invifible Particles, which are too fine for our Sight, even when affifted with the beft Microscopes.

IT is great pity that the Sagacity and Invention of very learned and ingenious Men fhould be turned a wrong way, and employ'd about things which are either altogether precarious and uncertain, or which if they fhould be fuppos'd true and capable of Demonftration, could be of little ufe in the Practice of Medicine. When a Man is told that the acute Pains which are fometimes felt in the Joynts and Tendons, are occafion'd by certain little fharp Wedges, or faline *Spiculæ*, which prick and wound the tender Filaments and nervous Coats of the Veffels, he is dispos'd without fcruple to give into fuch an account of the Matter, as extremely plausible at leaft ; and yet 'tis certain, that any Fluid, with a fufficient quantity of Motion, whatever the Figure and Texture of its Parts be, may diftend and overftain the Veffels, tear and wound their minute Fibres, and by a feparation of Continuity occafion Pain : in which cafe to infer barely from the Phænomenon or Symptom of Pain, that the material Cause muft be Salt, is juft as good a Confequence as it would be to conclude, that Fire is a Salt becaufe it occafions Pain.

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IT is certain in fact, that Salts, both fix'd and volatile, are often very efficacious in removing many of those Diseases the Cause of which is attributed to Salts; and it would be of no consequence here to say, that Salts of one Figure and Texture may be proper to drive out and dislodge the Salts of a different kind: for since we know but little or nothing of the ultimate Figures and Textures of any Salts, when they are alter'd by and dissolv'd in the Blood, this would be only to run the account of the Matter into the dark, and render the Cause more inexplicable than the Diseases; for it must still appear very wonderful, that Diseases should be cured by increasing the morbifick Matter.

A L A T E ingenious Theorist, being convinced of the Weakness and Insufficiency of the common Hypothesis concerning the animal Spirits, took the Courage and Resolution, in despite of the popular Torrent, to throw them quite off, and leave them out of his Account in the Theory of Diseases: but then he introduces the *biliofe Salts* in their room; and whether upon this occasion he has not coin'd a new Hypothesis, equally absurd, immechanical, and unphilosophical with the other, must be left to the Judgment of the learned World. But for my own part, I must acknowledge, such is the dullness of my Apprehension, or the difficulty of the Subject, that what this Gentleman has said of the *biliofe Salts*, appears to me altogether

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as myſterious and miraculous, as the Accounts which others had given concerning the incomprehenſible Operations of the *animal Spirits*.

How theſe bilioſe Salts ſhould come to exert their principal Action upon the Stomach, which does not ſeem to be the natural ſeat of their Reſidence; after what manner they ſhould be from thence froth'd into the Blood, and by what Mechanifm they are there alternately expanded and contracted, ſo as to become the chief Inſtruments of muſcular Motion, as well of that which is natural, neceſſary and uniform, as of that which is voluntary, and under the command of the Will; by what means theſe bilioſe Salts ſhould bring a Man to ſleep and then awake him again, firſt raiſe and exaſperate, and then ſink and moderate the Paſſions, and be the great Inſtruments of Thought, Intelligence and Cogitation, as ſeated in the Stomach; theſe are beyond all diſpute very deep Speculations, which require a farther Explication, and for which the Publick would certainly be much oblig'd to this great and learned Phyſician.

I WOULD not have this paſs as a Reflection on a Gentleman, of whoſe Abilitys in general I am very well ſatisfy'd; I am ever apt to ſuſpect my own Underſtanding and Judgment, when they happen to be contrary to the Opinion of greater Men: but this ought not to encourage a *criminal Modesty*,  
or

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of any such over-scrupulous Civility as might be an injury to Truth, or detrimental to Mankind; especially since the Gentleman I here aim at, has certainly taken a much greater freedom with others, than I am willing to take with him. And if upon such an occasion he met with some Usages not very civil, I doubt not but his Generosity, good Sense, and acquaintance with human Nature, will dispose him to Forgiveness.

ONE thing, however, the Publick ought to be satisfy'd in, as being a Matter of high consequence, and that is this, whether these biliose Salts, in this large extensive account of them, be not altogether as unintelligible, immechanical and useless, as the common Hypothesis concerning the animal Spirits.

THE necessity or usefulness of Theorys in general, and the possibility or impossibility of investigating the *Causes* of Diseases, being now brought into question, and made a sort of Controversy or Party Quarrel among the Physicians, it may be proper here briefly to state the Matter in dispute, to account for the seeming Difference, and endeavour to reconcile the Partys at variance.

THE *Cause* of a Disease may stand either, first, for the intrinsic essential Texture and Constitution of the morbid Matter, upon the Principles of the *Corpuscularian Philosophy*; or, secondly, for the primary Seat and original Constitution of the Disease itself, as

it internally affects the animal Organs and Fluids, and from which all the Symptoms, or outward sensible Appearances necessarily follow : or lastly, for the remote Occasion, or extrinsick Agency, by which any such Irregularity or Disorder is induced and brought on.

U N D E R the first of these acceptations, the Inquiry concerning the Causes of Diseases, must necessarily be as uncertain and precarious as the Hypothesis upon which it is founded ; the original, intrinsick, and essential Texture and Constitution of Bodys, from which their nominal Essences, common specifick Differences, or sensible Qualitys arise, are but very little or not at all known to us ; and from imaginary Causes, the Effects can only be imaginarily accounted for. From this sort of Philosophy, a great number of general, undefin'd, and therefore unintelligible Terms, have been introduc'd into Physick and the Accounts of Diseases; such as *Tartar, Sulphur, Mercury, Acid, Alcalys, Nitro-sulphureous, Nitro-aereal, Sulphureo-saline Particles, animal Spirits, biliose Salts*, with many more of the like nature, which signify either just nothing, or which is the same in effect, any thing at pleasure.

F R O M hence it comes about, that a Theory in Physick often passes only for the Philosophy of Unintelligibles, and is accordingly prejudg'd and decry'd, right or wrong, by some without hearing, as the mere idle Amusement

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usement of such as, wanting Business, prefer Imagination to Experience. But they who draw such Consequences from the misfortune of those who have but ill succeeded in their Theorys of Physick, seem not to be aware how effectually they are ridiculing and exposing themselves and their Profession, while they own in effect, that Medicine is nothing else but mere Empiricism, and that all Physicians are equally Quacks, with this only difference, that some Quacks have more Practice and Experience than others.

H O W E V E R, it must be allow'd, that in the Sense of the Word, as last defin'd, the *Causes* of Diseases are to us unknown, and ever will be so; nor is it perhaps any great matter whether they are known or unknown. But then the *Cause* of a Disease sometimes signifies the original Disease itself, as it internally affects the animal Organs and Fluids; and from which original internal State and Constitution of the Disease, all the Symptoms or outward sensible Appearances must necessarily follow. And this I take to be the true Notion of Causes and Effects, so far as the *Rationale* of Physick, or any Theory of Medicine is concern'd about them.

'T I S plain that the Names of Diseases, under their common Acceptation, are affix'd, not to the real internal Constitution, or morbid State itself, but to the Complication of Symptoms, or outward sensible Appearances; which Complication of Symptoms, join'd to-

gether under a common Name, constitutes the complex Idea, or nominal Essence of this or the other particular Sort or Species of Diseases. Thus when the biliary Ducts, or Pipes which convey the Bile from the Liver to the Intestines, are obstructed, the consequent Symptoms, such as the Yellowness, the hard white Stools, the Costiveness, the thick turbid Urines, with the other Symptoms usually attending the Disease, being join'd together under a common Name and complex Idea, is called the *Jaundice*; which Disease would pass under the same Name, and admit of the same Cure, tho the Cause of it, or the Obstruction of the biliary Pipes should be absolutely unknown, or never once thought of. But then 'tis plain in this case, that the Obstruction of the Bile is strictly and properly the Disease; and the Complication of Symptoms, to which the Name is affix'd in common Acceptation, are only the Effects and Consequence of it. And after the same manner, any original proper Disease, as it respects the internal State and Disposition of the Organs and Fluids, may be consider'd as the Cause of the consequent Symptoms. And this Method of reasoning from the Effects to the *Cause*, that is, from the Symptoms given to find out the internal, real, and proper Disease, is of such consequence, that a Physician can make no rational Judgment without it. 'Tis this capacity and skill of reasoning from the Symptoms to the internal, original, and proper

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per Disease, that distinguishes a true Physician from a Quack or ignorant Pretender, and that renders his Judgment preferable to that of a Nurse, a Midwife, or a Country Farmer, who might chance by Recipes to cure a Jaundice, or any other Disease, without knowing what it is, or from whence its Symptoms arise.

I HAVE instanced here in a Jaundice, as being a popular Disease and commonly known; but what has been said may be equally apply'd to a Fever, a Dropsy, or any other Disease, as I hope to evince in some of the following Propositions. 'Tis therefore a right knowledge of the animal Machine, and a just reasoning thereupon, from Effects to their Causes, from the outward sensible Appearances to their internal and more remote Originals, Sources, or Fountains, that can alone qualify a Physician to make such Judgments of Diseases as must secure his Success, and justify his Practice.

BUT the word *Cause*, as apply'd to Diseases, is sometimes taken for the antecedent Occasions by which they are brought on, such as Over-heating, taking Cold, bad Air or Diet, immoderate Evacuations, violent Passions, or any excess in the Nonnaturals; all which may help a Physician to form a right Judgment concerning the original morbid Constitution, or the Disease itself: but as the same antecedent occasional Causes produce different Effects at different Times, and in

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different Constitutions; so 'tis the Symptoms alone, or sensible Appearances of the Diseases, that can certainly be depended on in this case.

THE Disease being thus known, or found out from the Symptoms, and consequently the proper Indications of Cure; the next Inquiry is after the Remedy, or such Medicines as will most effectually answer the general Indications: and this is what can only be known by Experience, and can never be obtain'd by any Method of Reasoning *à priori*. No chymical Tortures, microscopial Inspections, or other Methods of Trial without Experience, could ever have inform'd us of the Powers and Propertys of Medicines, or what Effects they will produce within us.

WHO could ever have imagin'd, if Experience had not confirm'd it, that blistering with *Cantharides*, which abound with such an extremely pungent active and caustick Oil and Salt, would so powerfully cool and dilute the Blood in Fevers? Who could ever have known, but by actual Experience of its Effects, that the Bark would so effectually, beyond any thing else, correct the Errors of Concoction, or prevail so exceedingly in intermitting or remitting Fevers, and in almost all periodical Diseases?

THE different Effects of Mercury Sublimate and Calomel, could never have been  
found

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found out by any chymical Analysis, or upon the Principles of the Corpuscularian Philosophy. And the like may be said of any other Substances with regard to their different Effects upon the animal Organs and Fluids; their peculiar Efficacy could never have been found out *à priori*, and can only be known by Use and Experience.

THE Poison of the Viper indeed discovers some odd Phænomena when view'd thro' a Microscope; but there are many other things perfectly innocent, which give us either the very same, or altogether as formidable an Appearance.

NOTHING but Use and Experience could have inform'd us, that Opium will so gratefully affect the Nerves as to procure Sleep, ease Pain, and stop a Diarrhæa; that Saffron will so effectually heat, attenuate, and rarefy; that black Hellebore will so powerfully cool, attenuate, depress, and condense the Blood; and that Mercury has such a prodigious Efficacy in dissolving and discussing the Tumors and Concretions of the Glands.

IN short, the peculiar sensible Qualitys and Effects of Bodys, depend on a certain particular Texture and Cohesion of their minute invisible Parts, which are as much unknown to us as the different Arrangement of Particles upon the Surfaces of Bodys, or the differently modify'd Vibrations of elastick Bodys, upon which the various Refrangibility of Light, and the variously modify'd Undulations of the  
Air

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Air depend, and from which the different and respective Ideas of Colours and Sounds are excited in the Mind.

HERE therefore, where we cannot come at the necessary *Data*, philosophizing is trifling ; and they who in such Cases affect Eloquence and Ostentation, may amuse and surprize the Vulgar, while they will certainly expose themselves to the just Ridicule and Contempt of the truly Learned.

THESE, I think, are the proper and distinct provinces and boundarys of *Theory* and *Experience* in the Practice of Medicine. 'Tis from the Knowledge of the animal Oeconomy only, or the Laws and Principles of Motion in the animal Machine, that the Disease can be found out by a rational Deduction from the Symptoms : and from hence alone can the general Indications of Cure be taken. For he who is ignorant of the Disease, or the real internal state of the Organs and Fluids in which the Disease consists, can never form any rational Judgment of the most proper Methods of Cure.

ANY one by a little reading, may easily inform himself of the real or reputed Powers, Virtues, and Propertys of Medicines, so far as the Experience of others have been committed to writing, and reduced to general Rules ; but this is the least part of a Physician, and he who only knows thus much, knows only how to act at random and to do mischief. Every Apothecary (or even his  
Man

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Man at a Year's standing) may be acquainted with the several Classes of Medicines made up by him, or sold in his Shop; he may be well vers'd in the several Tribes of Simples and Compounds, and be sufficiently acquainted with the several Classes of Catharticks, Emeticks, Sudorificks, Diureticks, &c. and yet be no better a Physician than his Horse. 'Tis one thing to know how to bleed, purge, vomit, &c. and a quite different thing to know when, and under what particular Circumstances either the one or the other of these is to be chosen; how far to be allow'd, and when or by what means to be moderated and restrain'd. The former may be got by reading, or learning by rote; but the latter can only be obtain'd by a just acquaintance with that part of natural Philosophy which respects the animal Oeconomy.

PARTICULAR Rules, grounded upon Experience, and laid down in Books for all the variety of Cases, complications of Symptoms, and continually fresh arising Incidents in Practice, are impossible; but the Reason of things is always the same: and a seasonable varying the Method, as the various Symptoms arise, and according to the different State and Gradations of the Disease, is that in which the Physician discovers his principal Judgment and Skill.

SINCE the Powers and Propertys of Medicines, or the Effects they are capable of producing within us, can be only known by  
Use

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Use and Experience ; a faithful account of these, grounded upon just Observation, and a long continu'd impartial Trial, must certainly be a matter of the utmost Consequence, and is plainly a Debt due to Mankind. And yet after the Experience of so many Ages, there is nothing even at this Day, more uncertain or precarious than the *Materia Medica*. Among the vast number of simple and compound Remedys, recommended under great Names, and celebrated with lofty Encomiums, when a Man comes to make an impartial Trial for himself, he will find but very few of them that can be much depended on : for such has been either the Rashness or Credulity of those who have undertaken to give us the Virtues and Propertys of Medicines, that for the most part, any great Expectation raised upon them, serves only to delude the Hopes of the Patient for a time, and finally to disgrace the Physician. And from hence, doubtless, it came about, that the Practice grew more uncertain, and less successful in proportion to the bulk of the *Materia Medica*, and the numerous new Recipes and Remedys added continually from time to time, to the multitude of useless ones before.

'Tis true, indeed, that the *Materia Medica* has of late been very much reduc'd, and a great many precious Trifles and celebrated empirical Specificks have been laugh'd at and thrown out ; but still perhaps the greater  
part

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part of what remains may deserve the same Fate: for it must be own'd, that the peculiar and distinct Virtues of Simples, have been never yet subjected to a sufficient Scrutiny, or establish'd upon any such experimental Authority, as might be capable of supporting their common Reputation. Every experienc'd Physician must know, that the Qualitys of Simples are generally deliver'd with such great confusion and uncertainty, that not one in forty will answer the Character they bear; and that many things are still cried up for a thousand divine Virtues, which are scarcely endu'd with any one good Property; inso-much that a young Physician at his first setting out, has not so much as a fair Chance for it, whether his Expectations from the many celebrated Prescriptions and boasted Remedys he will meet with, shall be well or ill grounded.

FROM this generality, indistinctness, and confusion of Ideas about the Virtues of Simples, not sufficiently establish'd upon any honest impartial Experience, arose doubtless the humour of compounding Medicines with so much trouble and to so little purpose; while the main bulk of the Composition is often made up of things useless, if not hurtful, and contrary to the general Intention, and the only efficacy confin'd to a very few of the Ingredients, which bear but a small proportion to the rest. But this, I think, is certain, that when a Disease is well understood, the

I Cure,

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Cure, so far as it can be effected at all, will depend upon a very few Remedys, and those of the plainest and most simple Composition. And there cannot perhaps be a surer mark of a Novice or *Ignoramus* in his Profession, if he be not something worse, than the affectation of a multiplicity of pompous Ingredients in almost every thing that is given: by which the Doctor seems to prescribe more for the Apothecary than for the Patient; instead of a Course of Medicine sends in a Course of pharmaceutick Diet; and loads the Files with Bills, that might at a little distance be mistaken for Deeds of Conveyance and Court-Rolls: but this certainly is a great Evil under the Sun, which *Solomon*, had it happen'd in his Days, must have taken particular notice of, since nothing can be better entitled to the Censure of *Vanity and vexation of Spirit*.

EVERY one, I think, who has any just concern for the Health and Happiness of Mankind, must reckon himself oblig'd to contribute what he can towards the removing or preventing this Mischief, so far as it depends on that generality, indistinctness, and confusion, in which the *Materia Medica* for the most part still lies: to which purpose, if a sufficient number of able, impartial, and well-experienc'd Physicians would but once undertake to give us in a faithful Account of the Powers and Propertys of Medicines, (especially the most simple and uncompounded)  
under

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under the several particular Cases and Intentions of Cure in which they have most constantly and regularly observ'd their good Effects; this would doubtless be the most effectual way of establishing a more rational, safe, and generally successful Practice, and of disgracing and throwing out that remaining superfluity, and useless load of officinal Lumber, which is still retain'd under the Name of Medicines, to the great Detriment of the Publick, and defeated Hopes of Valetudinarians.

I AM clearly persuaded, that abstracting from Diet, the Medicines which are capable of answering any great Intentions of Cure among the animal and vegetable Substances are very few, and might easily be reduc'd to such a number, under their manifest and sensible Operations, as neither to overload the Memory nor confound the Judgment.

VEGETABLE and animal Specificks I know are abundantly cry'd up in great Numbers, even in the most obstinately fix'd, glandular, and chronick Cases; but it might easily be demonstrated, that they cannot possibly effect what is pretended of them, nor in the least come up to the several Intentions for which they are recommended: and whenever any such Cure is supposed to be done by them, the Physician may well cry out, O Patient, great is thy *Faith*!

THE Chymists indeed, finding Mercury in many Cases to be a great Remedy, thought  
by

by torturing it into a thousand different Appearances, and mixing it with all other sorts of mineral Substances, to have obtain'd from it at last some absolute infallible Catholicon for the Cure of all Diseases, and so to have made it a happy *Succedaneum* to the *Tree of Life*: but after all these fiery Trials, upon a thing that Nature has provided to relieve Mankind under some of the greatest exigencies of Disease, perhaps the plainest, simplest, and mildest Preparations of Mercury are still the best; and by such time as the Conveniencys and Inconveniencys of its rougher and more operose Preparations are well balanc'd, I doubt not but this Observation will be sufficiently justify'd.

THIS Ignorance, Impudence, Enthusiasm, and empirical Ostentation of the old Chymists, is doubtless equall'd, if not much out-done, by the numerous Tribe of modern Quacks, that swarm up and down in every part of the City and Country, with their boasted Catholicons and Specificks; and who, while they pretend to certain universal Remedys, capable of curing all Diseases, by rectifying all the irregular Motions of the Blood, cleansing off all the obstructing Viscidities and Concretions in the Glands, and reducing the Solids and Fluids to their natural and due state of Action; take Money at the same time for an infinite number of appropriated Medicines, peculiar to every particular Disease or prevailing Symptom. Thus the

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the Catholicon, which does every thing at once and in general, gives way to the Specifick which is brought in upon every particular occasion, to do what had been as effectually done before. And thus the Quack, who is all things in general, and every particular thing by turns, appears to be nothing else but an empty vain Pretender.

WHETHER the Word *Specifick*, as used in Medicine, has any fix'd determin'd meaning, is hardly perhaps worth while to inquire; but this I think is certain, That there cannot be a truer mark of a Cheat in his Profession, than of one who crys up any thing as a universal Remedy, or makes great Pretensions to a multitude of *Nostrums*, *Arcana*, and Specificks of his own.

THE original distinct morbifick Constitutions are not very numerous, and may easily be reduced to a few general Heads; and the primary Medicines of any great, remarkable, and distinct Efficacy, as they are plain, simple, and uncompounded, so perhaps they are not much more numerous than the original morbifick Constitutions themselves.

Now where any particular morbid Constitution exists distinctly, and is not mix'd or complicated with any other, some primary simple Medicine of peculiar Efficacy under that Constitution, such as Nature has prepar'd, will suffice for the Cure, and any farther artificial Pomp or *Apparatus* would be needless.

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BUT

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BUT because the originally distinct Constitutions of Diseases, are for the most part complicated, and apt to unite with and run into one another, so as to form a compound Disease; in this case, the different Complication of the *Disease*, which can be known only by the present circumstantial Differences in the *Appearances* and *Symptoms*, must determine the Nature, Quality, and different Proportions of the compound Remedys. And such are the different Complications of Diseases, and the different Species and Modifications of the Symptoms in particular Cases, that the same precise Composition of a Disease is scarce ever to be found in two Persons alike, or in the same Person at different times. And this shews the necessity of a rational extemporaneous Practice, in which the compound medicinal Course must be suited to the complicated Disease, as judged of by the present circumstantial Appearances and Symptoms; and at the same time evinces the impossibility of obtaining this great end of Practice by any fix'd and stated Prescriptions, or canonical Compounds.

NATURE indeed always acts upon a few plain and simple Principles; but these are so infinitely diversify'd in her particular Operations, as not to be reducible to any certain determinate number of general Rules, but must be understood and applied by a Method of right reasoning from Effects to their Causes, in which every Man must make his own  
Rules

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Rules and Canons of Practice for particular Cases, as he has a present Occasion for them.

THIS is evidently so in Arithmetick, Geometry, Mechanicks, and every other Subject which is mix'd, and made up of Theory and Practice: and this, in the case before us, must ever distinguish a Man of Judgment and Skill in his Profession, from all others who may pretend to what they understand not, or have no Genius for.

THIS Method of reasoning is excellently exemplify'd in the *Newtonian Philosophy*; where by first evincing Gravity, as universal in fact, and then applying that general Principle to the several Phænomena of Nature, a vast number of particular Appearances, which were before inexplicable, are plainly and demonstratively accounted for.

I HAVE therefore employ'd the *first Part* of this Work upon the Method of establishing the Principle of Gravity as universal in fact, and applying it to some of the principal Phænomena of Nature; not only as it is of some consequence in the Subject I am writing about, and has accordingly been touch'd upon already by a Gentleman very considerable, and justly celebrated in his Profession; but chiefly as it is the best Specimen and Exemplar that could be given of the general Method of right reasoning in all other cases, and particularly in the Theory and Practice of Medicine.

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IN the *second Part* I have endeavour'd to fix and ascertain the general morbidick Constitutions; to shew what are their peculiar Symptoms, and how they may be variously mix'd and complicated with each other; that the Complication of Symptoms being known, the compound Disease might be found out. And I have here added so many *Corollarys* and *Scholia* with respect to Practice, as to anticipate in great measure what I at first intended for the *third* and *last Part*, which therefore will be found very short. But to compensate farther for this, I hope for an opportunity some time or other to publish something more particular upon the Practice, as grounded upon the Principles here laid down.

I AM sorry that my other Affairs, and my state of Health, should have kept my Friends so long in expectation till they are impatient of the Delay; but having at length finish'd what I intended, I shall be very glad if the general Opinion be not alter'd, and the Publication now at last thought too soon. I am sensible how extremely difficult it is to write a good Theory of Diseases, and how impossible to satisfy those, who have already strongly imbib'd and retain'd a different or contrary Scheme of Principles: but notwithstanding the difficulty of writing well upon the Subject, I comfort myself however with this, that 'tis almost as difficult to write worse than others have done before me. And therefore

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fore with such sufficient Authority, and in so much good Company, it will be indifferent to me whether what may be thought amiss in this Performance, be imputed either to the Difficulty of the Subject, or to the Incapacity of the Author. I speak not this with any such mere indifferency, as if I had resolv'd to give up the Principles I have here advanc'd, without a just Defence upon a proper occasion. Such a Disposition would be unworthy of a Man who pretends to any Concern for Truth, or Service to the Publick: and therefore, whatever may be fairly objected from Reason or Experience, I shall think myself oblig'd to consider and reply to. But if any one who plainly discovers himself to be unacquainted with the Philosophy of Nature, and the History of Diseases, shall think fit to become my Adversary from Spite, Envy, or Ostentation; I shall revenge upon him only by silence, sit still as easy and unconcern'd as if no such thing had happen'd, and leave the Book against any such feeble Opposition to shift for itself.

It is now about five years ago that I ventured abroad the first Impression of this Work; since which there have been two worthy Gentlemen of the Faculty condescending so far, as to take notice of me in publick.

The first was Doctor *Rutty*, in his Treatise of the urinary Passages; where he *asserts*, against me, the sufficiency of the *Bellinian* Hy-

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pothesis of Secretion, particularly with regard to the natural Evacuation by Urine. I say, he *asserts* this Hypothesis, as sufficient in this case to account for all Phænomena; for he did not think it worth his while to prove it, or to answer to what I and others had offered to the contrary. And perhaps the Doctor might not think it to his purpose, while he was acting the Part of a Master, and dictating anatomical Lectures, either to prove his own Hypothesis, or refute any body's else. But as this Gentleman is now dead, and cannot speak for himself, I shall say no more of that Matter here; but only to inform the Reader, that in *Prop. 12. Part II.* of this Edition, I have endeavoured to set this Affair in a clear Light; and have, as I presume, fully demonstrated, that not only Dr. Rutty but all others who have espoused the *Bellinian* Hypothesis in the case before us, have been very much mistaken.

BUT the most formidable Adversary of all is, the nameless Author of *A Discourse concerning Fevers, in two Letters to a young Physician.* In which he attacks and explodes all Hypotheses and Theorys in *Physick*, whether *physical* or mechanical, as vain and delusive. Now if he here means any thing, it must be this, that *Physick* admits of no Principles, Theorems, or general Truths, which are capable of being applied in particular cases as the rational Grounds of Practice. But if this be really so, to what purpose does he here set up

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up for a Master in Physick, and why does he pretend to teach a thing, that upon his own Supposition cannot be taught or understood, as depending upon no Principles? Doubtless we ought to take this Author's own word for it, that he has no physical Knowledge, or no rational Principles and Grounds of Practice; he understands not any one Law of Nature, or Principle of animal Motion, that can be of the least use to him in the knowledge and cure of Diseases: and this I presume will be easily admitted. But then I hope it will not follow from hence, that every body else must needs be as weak or as impertinent as himself.

BUT when this learned Gentleman has set aside all Theorys, and mechanical Reasonings upon the Laws of Nature and animal Motion, what has he to depend on or to guide him in Practice? Does he cure Diseases by Instinct or Inspiration? or has he a certain Number of Specificks to recur to upon all occasions, and a familiar Spirit about him, to tell him when and how they are to be applied? If this be not the case, he must certainly stand but a very poor chance in the Opinion of all *reasonable Judges*. With others it will be thought, that he never makes *himself* unaccountable till his *Practice* is so, and that he then only scorns to give a Reason, when he has no Reason to give.

BUT this Author, to prove that there is nothing in Theorys, general Principles, or mechanical Reasonings in Physick, endea-

vours to set the mechanical Writers at variance among themselves, and shews that several of them, in some cases, have argued upon different Principles, and drawn very different and contrary Conclusions from them. And is not this, I beseech him, his own case, and the case of all other such profound *practical Writers*? who, after all their boasted Experience and celebrated Specificks, are scarcely any two of them agreed about the true Method of curing any one Disease: what one sets up as salutary and necessary, the other runs down as dangerous and mortal: one declares absolutely, you must do this or die; the other crys out, if you do it you are infallibly a dead Man. While perhaps both these Pretenders are specifick Men, neither of them capable of giving a Reason for what they say, one more than the other. We have found it so by *Experience*, is the first and the last Reason of such Quacks, and all that they can say; and while they are eternally at War with each other, they leave the Patient no possible Criterion or Rule of Judgment, which of their different and contrary Methods is most reasonable or likely to succeed.

BUT to bring this Matter to some Issue, and to give the Reader a clear and short View of this Debate, it may be proper here to observe, that the Gentlemen of the Faculty, as the Practice now stands among us, may be divided into two different Sects or Partys, under the Denominations of the Mechanical and Specifick

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Specifick Men, or the Mechanics and Specificians of the Profession: and as this is a most essential Distinction with regard to the different Merits and Pretensions of Physicians, it will be necessary here to explain it.

IT must be observed therefore, that Medicines may be conceived to operate and produce their Effects after two different manners; either by some obvious sensible Qualitys, producing their proper adequate Effects in consequence of the known Principles and Laws of Motion to which they are referr'd; or else by some secret occult Quality, producing such Effects as cannot be ascrib'd to, or explain'd by any of the known establish'd Principles and Laws of Motion. The first of these is call'd the *Mechanical*, the other the *Specifick* Effect or Operation of Medicines. Now from hence it is very plain, that a *specifick Operation* is but another Name for an *occult Quality*; and that as this always has been, so while it is admitted it ever must be the common Subterfuge of Ignorance and Impudence, in any Craft or Profession whatever.

FOR about two thousand Years, from the Days of *Aristotle* till the middle of the last Century, the Doctrine of occult Qualitys and their specific Operations universally prevail'd, especially in the Schools among the learned Triflers; which covered the whole Face of Nature with a deep impenetrable Darknefs: every thing was explain'd either into its unknown

known self, or into something still more mysterious. We saw by the visive Faculty, and understood by the intellectual Faculty; Digestion was performed by the digestive Faculty, and Secretion by the expulsive or secretive Faculty; and so of all the rest.

ABOUT two thousand Years, as I observ'd, having pass'd in this scholastick Reasoning upon nothing, and drawing Consequences from mere insignificant unintelligible Sounds, *Des Cartes* attempted to introduce a more hopeful and successful Method, by reasoning upon some sort of Ideas, and by ascribing natural Effects to certain intelligible and at least possible Causes; but unhappily mistaking the true Laws of Motion, and reasoning mechanically upon immechanical Principles, he had the ill luck to give a very wrong Account of most of the Phænomena of Nature. For indeed the case was this, that *Aristotle* had no Data at all, *Des Cartes* made his own Data; and tho he was a good Mathematician himself, yet he made no use of it by any just mechanical Application, in order to discover the real determinate Forces and particular Laws by which Bodys act upon each other.

THIS modern Philosopher was however deservedly admired and applauded, because if he had not hit upon the true Laws of Nature, he had at least introduced some Light, laid a Foundation for farther Discoverys, and set Mankind upon a better Method of Inquiry.

BUT

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BUT at length the great and immortal NEWTON arose with a Genius astonishing to the whole World; and like a divine Instructor relieved Mankind from that Darknefs, Perplexity and Uncertainty in which they had been loft and wandering for fo many Ages, with refpect to the Laws of Motion and the Constitution of the Univerfe. He investigated and demonftrated the particular determinate Principles and Laws of Motion by which all Bodys mutually act and re-act upon each other, whether they are folid or fluid, elaftick or unelaftick. He explain'd the celestial Motions in their moft difficult Phænomena, and traced them to their minuteft Irregularitys, from the one fimple and univerfal Principle or Law of Gravity. He demonftrated the particular Law of the Centrifugal Force, which takes place in the expanfible and compreffible Atmosphere; and informed us of the other Law of Attraction, which obtains only in the very minute Particles of Matter, at infinitely or indefinitely fmall Diftances; by which the various Degrees of Cohesion in the Parts of Bodys, the rife of Water in fmall Tubes, the fublimation of Vapours, the afcent of the Sap in Plants and Vegetables, and the Circulation of the Blood thro' the minuteft capillary Arterys, Lymphaticks, and fmalleft Vafculæ of the Bones, may be underftood and explain'd.

ONE would be apt to think, that fuch Principles as thefe, fo fully confirmed and de-

demonstrated, must be capable of being applied to the subject of animal Bodys, as the most likely way to set the Practice of Physick, or the Method of curing Diseases, in a clearer Light. But not to inquire from what Fate it comes about, it must be own'd, that not a few Gentlemen of the Faculty, and who would be thought no unworthy Members of it, have been and still are pleased to declare themselves of another Opinion. In their modest Sentiments, the Practice of Physick cannot depend upon any general Principles; there is no such thing as any mechanical Effections or Operations in the cure of Diseases, to be brought about by the obvious sensible Effects and Propertys of Medicines, upon the known Principles and Laws of Motion. This is a Method which they understand not, and cannot apply; and therefore they are ready to rise up in Arms against any one who shall attempt to introduce it.

BUT I would not have it thought that I am here combating the whole Body, or even the principal part of the *learned* Physicians of the present Age; for to speak the truth, the Gentlemen of this Class, of which there are great Numbers, are quite out of the question: but the great Men I am now to contend with, tho many of them, by good Luck or Accident, make considerable Figures in the Profession, are yet, properly speaking, altogether unlearned and illiterate; and so far as my Experience or Information reaches, there

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there is not one in forty of them that understands any thing even of the first Principles of Arithmetick, Geometry, or Mechanism; or knows how to estimate the Forces and Quantitys of Motion in two Bodys, where the Velocitys and Quantitys of Matter are given.

BUT not to insist upon this, I shall leave the Reader to judge as he shall think fit, concerning the Grounds and Reasons of such a Conduct: it is my business at present, to consider the general state of Physick as it now subsists, and has subsisted for many Ages; and to shew what I think may and ought to be done towards its Reformation. That such a Reformation, so far as it can be effected, is highly necessary, must be sufficiently evident from the general ill Success of the Profession, and from the common Acknowledgments and Complaints of both Physicians and Patients.

THAT the supposition of the occult Quantitys of Medicines and their specifick Operations in the cure of Diseases, has been the great prevailing Principle in Physick, and generally receiv'd among Physicians, is as evident and notorious in fact as most of the Books that have been ever written and publish'd upon that Subject.

UPON this Supposition, and in this Method of Procedure, it was impossible to set any Bounds to the *Materia Medica*, or to reduce the Practice to any rational general Principles; while the whole vegetable, animal, and mineral Kingdoms have been ransack'd and tortur'd, in order to find out these

can teach him nothing but the Blunders of his own Practice, and the Insufficiency of his Scheme. Upon this Plan the Apothecarys in general are as good Physicians as the best of us ; and I cannot see how any Graduate in Physick could dispute Precedency with a Nurse, Midwife, or any experienced Matron that is older than himself, unless he would set her aside merely for not having a Diploma. Nay, upon this Scheme, we have several young People among us, who at twenty or twenty-five, having read two or three *Dispensatorys*, understand the specifick Virtues of Medicines as well as any Graduate in the World ; and being conscious of this Understanding, would scorn to take any Medicine from the best Physician alive, unless they knew what is in it, how it was compounded, and what specifick Propertys it might be possessed of.

SUCH specifick Patients would take Epidemical and Treacle-Water, or volatile Oils and Salts, with all their hearts ; but they will sooner die than be blister'd, or take Rubarb, Jalap or Mercury ; which tho they might have some sensible good Effects, have no such secret Qualitys as the other.

THIS senseless and impudent Pretence of curing Diseases by the occult Qualitys of specifick Remedys, is, and always has been the ground of all the Ignorance and Knavery that we meet with in Physick ; in this way a Man of any Artifice or Address will never want a colourable Plea to retain the Patient by feeding  
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up his Hopes from time to time, tho he finds himself never the better, but perhaps still grows worse and worse: if one Specifick will not do another shall be tried, and if that fails a third, and so on for ever; or as long as the believing Sufferer has any Money, Strength or Patience left. And then, after all, he is to be put under the Regulations of Diet, Air, Exercise, Bathing, mineral Waters, &c. all which are no Specificks, but their Effects such as are obvious and truly mechanical.

THE absolute Insufficiency and fatal Consequences of this Hypothesis, which pretends to specifick Cures by the occult Qualitys of Medicines, convinced all thinking Men long ago, that some other Method and Foundation of Practice must be necessary, before Physick could be brought to any tolerable degree of Certainty and Success. But it happen'd very unluckily that *Bellini*, who was one of the first who attempted animal Mechanism, or a more rational way of explaining the nature of Diseases, set out upon two Principles which were demonstratively false and impossible; and yet he assumed them as *Postulata*, without Proofs, as most others have done from his Authority by a blind Submission. And while Men have reasoned upon wrong Principles, their Conclusions must needs be wild, extravagant and contradictory, tho they may please to call them *mechanical*. *Bellini's* two main Principles, upon which he builds his whole Theory, were these.

1. THAT the whole Force and *Momentum* of the circulating Blood is deriv'd from  
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1. THAT the whole Force and *Momentum* of the circulating Blood is deriv'd from  
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the Heart, and from no other Power in Nature.

2. T H A T all the natural Evacuations are deriv'd from the Blood in the Arteries; or that no Parts of the animal Body are fed and supplied directly from the Stomach, but the Blood-Vessels only, while all the other Parts are supplied with their proper Contents by an intermediate Colature from the Arterys. And this he supposes to be the nature and sole use of the Glands. And from hence it has happen'd, that the Gentlemen who have herein implicitly follow'd *Bellini*, have contradicted the true Laws of Motion, and the real Phænomena of Nature, in almost every thing they have advanced about the Circulation of the Blood and animal Secretion.

*BORELLI* taking it for granted, that the whole Force by which the Blood and animal Fluids are impell'd thro' their proper Vessels, was deriv'd from the Heart, after a great Expence and Abuse of Geometry, ascribed an incredible Power to that Muscle; which yet not being sufficient to answer his Purpose, he was obliged, contrary to all the Laws of Motion, to suppose that the Heart, with a Force equal to 3000 Pound weight, might remove a Resistance equal to 180000; and as a necessary consequence of his Principle, had he not erred in the Computation, he must have made it near ten times as much, and the Weight to be moved must have been 500 times greater than the moving Force. This incredible and impossible Effect, he ascribed to the force of Percussion

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cussion in the Heart, which was wonderful in so great a Man; as if he had not known, that without Percussion there could have been no mechanical Communication of Motion at all.

DOCTOR *James Keill*, proceeding upon the same false Principle, and mistaking also a Proposition in Sir *Isaac Newton*, computes the force of the Heart as not exceeding six or eight Ounces; which he thinks sufficient to surmount all the Resistance the Blood meets with in the whole course of its Circulation. And this Computation of the force of the Heart, or the Resistance to be overcome in the Circulation of the Blood, falls short of the other which *Bellini* had given us in the Proportion of about 5000000 to 1. And thus it is, and must be, when Men will go about to reason mechanically upon immechanical Principles.

A CELEBRATED Member of the Faculty, who, till within these few Years, had been universally allow'd as the greatest Physician in *England*, set out in the Practice with a new Theory of Fevers, and raised vast Expectations of a new animal Oeconomy; in which the deepest Mysterys of Nature were to be reveal'd, every Particle of the Blood measur'd and weigh'd, and the Powers of all the minutest Springs and Movements of the animal Machine adjusted, computed, and reduced to a mathematical Certainty, by the fluxionary Geometry.

BUT this animal Oeconomy never appear'd, and I shall make no Reflections upon the Theory, because the Doctor seems now to have no great Opinion of Theorys himself; and has, I believe,

believe, convinced every body of the Vanity of philosophizing in Physick. He has found out a better way of rendering Mankind immortal, without the knowledge of Mathematicks or Mechanism, only by Fasting and Prayer, by subsisting without Meat and Drink, and living by Faith above the World upon the philosophical Principles of *reveal'd Religion*. In short, he has plainly prov'd, that Souls gravitate as much as Bodys; that Interest is their proper Centre; and that Mathematicks and Mechanism can signify nothing, when a Man has once raised an indolent, implicit Reputation, and Experience has taught him an easier way of getting Money. But I must spare so great a Man, lest he should demonstrate from the Doctrine of Fluxions, and the Infinitude of his *spiritual Cone*, that I am mathematically, mechanically, physically, morally, analogically and hypochondriacally mistaken.

I HAVE said thus much, to shew that no Good can be expected in the Practice of Physick from the specifick Method, and that mechanical Reasonings can be of no use while they proceed upon wrong Principles. In the following Work, having set aside some false Hypotheses, I have endeavour'd to establish the true Principles and Laws of *animal Mechanism*. Whether I have succeeded or no must be left to the Judgment of others; but however it be, I expect Pardon at least, as having labour'd much upon this Subject, and design'd well to the Publick.

Bristol, July 25.  
1730.

T. Morgan.



TO  
D<sup>R</sup>. MORGAN,  
ON HIS  
Philosophical Principles of  
MEDICINE.

**D**ISTINGUISH'D Worth demands the  
Poet's Lays,  
Accept this grateful Tribute to your  
Praise,

Great is the Task, extensive is the Theme,  
Great as your Work, extensive as your Fame :  
Yet the bold *Muse* attempts the vast Design,  
And your Applause shall swell in every Line.

In the primæval happy Days of old,  
When golden *Years* their shining Circles roll'd,

When on wild Fruits and Herbs they liv'd content,  
And thankful took what Heav'ns rich Bounty sent;  
No noxious Humours stain'd their crimfon Flood,  
And what is *Phyſick* now, was then their *Food* :  
They bloom'd in Youth at threescore Years and ten,  
For *Nature* was the ſole Phyſician then.

DISEASE, at firſt, ſprung from her Parent *Vice*,  
And hence the *healing Art* deriv'd its riſe :  
*Bleſt Art* ! whoſe Power diſpels our Pain, and ſaves  
From pining Sickneſs, and devouring Graves.  
Plain Remedys, at firſt, were valu'd moſt,  
The Drugs were few, and moderate the Coſt ;  
The Sick were cur'd without a gilded Pill,  
A ſovereign Bolus, or a pompous Bill.  
As *Vice* increas'd, ſo *Phyſick* by degrees  
Increas'd its Empire, and increas'd its Fees.

IN after-times it more myſterious grew,  
As *Pride* prevail'd, and *Inter-eſt* came in view,  
Dreſs'd by deſigning Men in dark diſguiſe,  
And veil'd in awful Shapes from vulgar Eyes.

WITH

WITH *GALEN*'s Sect a cloud of Med'cines<sup>[came,</sup>  
Of various Form and venerable Name :  
*Physick* was all Confusion, all profound,  
While Jargon reign'd, and Learning lay in Sound ;  
Till the last Age appear'd, when Gleams of Light  
Dart thro' the Chaos, and dispel the Night.

THEN *BACON* flourish'd, in whose spaci-<sup>[ous Soul</sup>  
Unnumber'd Truths in beauteous order roll.

THEN shone the learned, the industrious *BOYLE*  
And fought out Truth with an unweary'd toil ;  
*BOYLE* on Experiment alone rely'd,  
And Nature, which he lov'd, was still his guide.

*LOCKE* now like some propitious Star appears,  
And his fair *Fabrick* of *Ideas* rears,  
Which all the Schoolmens Sophistry display'd,  
And welcome Light to every Art convey'd.

*SYDENHAM* then made the way to Practice<sup>[plain,</sup>  
Taught by no idle Fictions of the Brain ;

*SYDENHAM* the old, the simple way renew'd,  
Nor study'd what was *Great*, but what was *Good*.  
He rescu'd *Physick* from its useless load,  
And pointed out a more successful road.

THE Scene still brightens each revolving Year,  
And lo! fresh Wonders to our view appear;  
Lo! *Medicine* shines with *mathematick* Rays,  
The welcome Omen of *propitious* Days:  
Such was of late the pleasing vast Surprize,  
When *Northern Streamers* lighted all the Skies;  
When soon as shades of Night the Earth o'erspread,  
Amaz'd we saw *new Morning* o'er our head.  
Charm'd with the Tidings, many a *learned Sage*  
Does eager in the great Design engage;  
While new Discoverys their Researches crown,  
Give Health to others, to themselves Renown.

BUT tho such numbers have pursu'd the Theme,  
To You alone we owe a *finish'd Scheme*;  
All that *BELLINI*, or that *PITCAIRN* dar'd,  
At best is faint Essay with Yours compar'd;

The

The *Method* clear, each Part with Judgment <sup>[wrought,</sup>  
Enrich'd with *labour'd Skill*, and *depth of Thought*.

THE learn'd *BOERHAVE* will hail the grate- <sup>[ful Sight,</sup>  
And read you o'er with *wonder* and *delight*.  
While the *fam'd Tribe* you treat with such regard,  
Who best can judge of *Worth*, and best reward;  
The Man they love with just Applause extoll,  
And in their *shining Rank* your Name enroll.

THUS the *vast Genius* is at length reveal'd,  
Which long, too long, in darkness lay conceal'd;  
Thro' interposing Clouds it makes its way,  
And breaks, refulgent with celestial Day.  
So Gems disclos'd in some *Peruvian Mine*,  
With innate Fire, and rugged Lustre shine.  
Great Souls blaze out with their own native Light,  
Tho Fortune frown, and Envy wrecks her spight.  
You leave the beaten Circle of the Schools,  
And the dull Round of antiquated Rules:  
On *obvious Facts* your *Principles* depend,  
All to support our tottering Fabrick tend;

While,

While, by *just Consequence*, from these you draw  
 Some *fundamental Truth* and *useful Law*,  
 To guard Man's feeble Frame from fell Disease ;  
 Or, when we sink with Pain, to give us Ease :  
 To every Ail ascribe its proper Cause ;  
 For Nature's govern'd by *mechanick Laws*.  
 With nicest Skill you paint her outward dress,  
 In vain we'd penetrate the deep Recess ;  
 No human Eye her secret Springs can trace,  
 But lost in Mazes, leaves the fruitless chace.  
*Mount Ætna* thus conceals her unknown Fires,  
 And *rapid Nile* to hidden Paths retires.

SAGES now trust to Fairy Scenes no more,  
 Nor venture farther than they see the Shore :  
 They built on *Sense*, then *reason from th' Effect*,  
 On well establish'd *Faets* their Schemes erect ;  
 By these some new *Phænomena* explain :  
 Thus they proceed, and *Truth Divine* obtain.

SUCH was the Path *immortal NEWTON* trod,  
 He form'd the wonderful Plan, and mark'd the  
 [Road ;  
 Led

Led by this Clue, he travell'd o'er the Sky,  
And marshall'd all the *shining Worlds* on high,  
Pursu'd the *Comets* where they farthest run,  
And brought them back obsequious to the Sun.

MEN may on Fancy's airy Pinions rise,  
And in Imagination touch the Skies ;  
Be pleas'd with Theorys because they're new,  
And then for being pleas'd believe them true :  
On Nature call, but call, alas ! in vain,  
To foster all the Monsters of their Brain.  
Nature has no imaginary Schemes,  
No vain Chimeras, nor romantick Dreams ;  
She offers *Truth*, not *Fiction* to the Mind,  
Nor makes us fancy what we never find.

[reduce  
MATURE in Thought, you NEWTON's Laws  
To nobler Ends and more important Use.  
You show how heav'nly Orbs affect our *Frame*,  
And raise, or sink by turns the *vital Flame* :  
How *Moons alternate*, in their changing Sphere,  
Impress their Force, and agitate the Air ;

How

How as without successive Tides advance,  
While the pale Moon pursues her silent dance;  
So does the *refluent Blood* her Influence know,  
And Tides within *roll high*, or creep on flow.

WHEN *raging Fevers* kindle Flames within,  
Which dreadful glow o'er all the scorch'd *Machine*;  
You shew how Nature grows averse to Food,  
And pants for Liquors to dilute the Blood;  
Shuts up the Pores, and prudently detains  
The flowing Serum in the burning Veins.  
Your *gentle Med'cines* mitigate the Heat,  
And cool the Blood, without expence of Sweat:  
The Monster *Febris* flies the mighty Spell,  
In haste retires, and calmly seeks her Cell.

So when the *sultry Dog-star* reigns on high,  
And all the Fountains of the Earth are dry,  
When parched Fields look withering all around,  
And frequent Chasins divide the thirsty Ground;  
Indulgent Heav'n bids numerous Vapors rise,  
And lo! th' obedient Vapors croud the Skies;

While

*To the AUTHOR.* **lxi**

While bursting Clouds descend in Show'rs of rain,  
Revive the Plants, and cool the burning Plain.

*MED'CINE* from hence shall boast of sure Suc-  
[cess,  
Nor *Patients* long remain without redress,  
But raise, from Scenes of Death, their drooping  
[Heads,  
And flusht with sudden Life forsake their Beds.

FOR this shall future Ages sound your *Fame*,  
And distant Climates echo with your Name:  
Your *Work* itself will its Admirers raise,  
And Men that breathe by you, shall breathe your  
[Praise.

My raptur'd *Muse* sees with *prophetick* Eyes,  
New Ages roll along, new Nations rise:  
Sees *Physick* on *mechanick Reasoning* climb,  
And raise a Structure to the Skies sublime;  
Sees Sicknes fled, Health bloom in every Face,  
And Age creep on with slow, reluctant Pace.  
*Experience* with her Torch shall guide our Youth,  
Scatter the Mists, and light the way to *Truth*.

While dark Hypothesis no more prevails,  
 Nor *Pupils* listen to romantick Tales ;  
 Nor proud Authority, with bugbear Rules,  
 Controuls the *Church*, nor dictates in the *Schools*.  
 But *Liberty* sits Goddess of our *Isle*,  
 And peaceful Blessings all around her smile;  
 Darknes and Bigotry before her fly,  
 And *Truth* and *Virtue* grow beneath her Eye.

October 19.  
 1724.

*Sam. Bowden.*



**T H E**



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*L*AWS of Motion.

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PROP. II. *In all moving Bodys, the Spaces describ'd are as the Velocitys multiply'd into the Times of their Description.* ibid.

PROP. III. *A Body will describe the Diagonal of a Parallelogram by two severall Forces combin'd, in the same time that it would have describ'd one or the other of its Sides, by one or the other of these Forces, separately and respectively.* p. 3

PROP. IV. *If a Body be continually urg'd or impell'd by any given Force, acting upon it incessantly and without Intermission, the Motion thence arising will be uniformly accelerated; in which Case the Velocitys will be ever as the Times, and the Spaces described*

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*described as the Squares of the Times, or the Squares of the respective Velocitys.* p. 5

**PROP. V.** *The Gravity or Weight of Bodys is an accelerating Force; and this Gravity or Weight at the Surface, or at equal Distances from the Centre of the Earth, is directly proportional to the Quantity of Matter contain'd in such Bodys.* p. 7

**PROP. VI.** *If a Body moving with an equal Velocity in a given Direction, be at the same time continually and equally impell'd, drawn, or any ways urg'd to a given Point, without the Line of its uniform Direction; the said Body, by the Composition of these two Motions, will describe a Curve about the given Point of its central Force; in which the Areas describ'd by Lines drawn from the Centre, will be situated in the same Plane, and ever proportional to the Times of Description.* p. 10

**PROP. VII.** *If a Body revolves in a circular Orbit about the Centre, the centripetal Force generated in a given Time, will be ever equal to the Square of the Arch describ'd in the Time given, divided by the Diameter of the Circle.* p. 13

**PROP. VIII.** *If two or more Bodys revolve about a central Body, their centripetal Forces, or accelerating Velocitys towards the Centre, will be ever in a Ratio compounded of the Distances directly, and the Squares of the periodical Times reciprocally: that is, these Forces will be as the Radii or Distances divided by the Squares of the periodical Times.* p. 14

**PROP. IX.** *From the Law of the periodical Times given, to find the Law of the centripetal Force universally.* p. 16

**PROP. X.** *The Velocitys of Bodys revolving about a given Centre at different Distances, are universally as the Distances directly, and the periodical Times reciprocally; or, which is the same thing, directly as the Radii divided by the periodical Times.* p. 18

**PROP.**

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PROP. XI. *The primary Planets revolve about the Sun, the Moon about the Earth, and the Satellites of Saturn and Jupiter about Saturn and Jupiter, as their true and proper Centres: and the Law of their Revolution is such, that the Squares of their periodical Times, are as the Cubes of the Distances from their different and respective Centres.* p. 20

PROP. XII. *Let two or more Bodys be supposed to revolve about the Earth at different Distances, and to be retain'd in their Orbits by their Weight, or accelerating Forces towards the Earth's Centre; and I say, that the Law of their Revolution will be such, that the periodical Times will be in the sesquialterate Ratio of the Distances; or the Squares of the one as the Cubes of the other.* p. 23

PROP. XIII. *The centripetal Forces, or accelerating Velocitys of the Moon to the Earth, of the primary Planets to the Sun, and of the Satellites of Saturn and Jupiter to Saturn and Jupiter respectively; are universally in the reciprocal duplicate Ratio of the Distances from their different and respective Centres.* p. 25

PROP. XIV. *The accelerating Velocitys of any two Bodys towards each other, are reciprocally as the Bodys themselves, or directly as the Quantitys of Matter in the attracting Bodys to which the Acceleration is made. ibid.*

PROP. XV. *There is in all Bodys, and the several Parts of which they are compos'd, a mutual Attraction, Gravitation, or Conatus mutuo accedendi; which Force is of the same nature and kind with that which we call GRAVITY or Weight, by which Bodys tend to the Centre of the Earth; and is ever in a Ratio compounded of the Quantitys of Matter in the Bodys themselves directly, and the Squares of their Distances reciprocally.* p. 27

PROP. XVI. *The absolute central Forces, or Quantitys of Matter in attracting Bodys, are universally*  
d in

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*in the triplicate Ratio of the Distances of revolving Bodys from those Centres directly, and the duplicate Ratio of the periodical Times inverſly: that is, thoſe Forces, or Quantitys of Matter, are ever as the Cubes of the Diſtances, divided by the Squares of the periodical Times.* P. 32

PROP. XVII. *The Densitys of all central attraſting Bodys, are ever in the compound reciprocal Ratio of the Cubes of the Parallaxes of the Bodys revolving about them, multiply'd into the Squares of their reſpective periodical Times.* P. 34

PROP. XVIII. *If a Body, as P, revolves about another Body S; that other will likewise revolve about the former; that is, they will both revolve in the ſame Time about their common Centre of Gravity: and the Figures deſcribed about the common Centre of Gravity, and about each other mutually, will be reſpectively ſimilar.* P. 39

PROP. XIX. *If two Bodys S and P, attraſt or tend to each other mutually, with given Forces, and at the ſame time revolve about the common Centre of Gravity C; I ſay, that with the ſame Figures thus deſcribed about the common Centre of Gravity, a ſimilar and equal Figure may be deſcrib'd with the ſame Forces, by either of thoſe Bodys about the other conſider'd as immoveable.* P. 40

PROP. XX. *If two Bodys attraſting each other mutually, revolve about their common Centre of Gravity, the Diſtances remaining the ſame; the periodical Time about the Centre of Gravity, is to the periodical Time of one of thoſe Bodys revolving about the other, by the ſole Attraſtion of that other, in the ſubduplicate Ratio of the fix'd or central Body to the Sum of the Bodys.* P. 42

PROP. XXI. *The ſame things ſuppoſed as in the laſt Propoſition; I ſay, that the periodical Times being equal, the Diſtance of the Bodys revolving about*

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*about their common Centre of Gravity, is to the Distance of the same Bodys, where one of them revolves about the other considered as immovable, in the subtriplicate Ratio of the Sum of the Bodys to the fix'd or central Body.*

P. 43

PROP. XXII. *If a Body revolving about a given Centre, has its Motion disturb'd by the Attraction of some other Body drawing it to a different Centre; 'tis requir'd to find the general Laws and Proportions of the perturbing Forces.*

P. 45

PROP. XXIII. *If a Corpuscle be placed within a Concave Sphere, whose Surface consists of Parts attracting each other mutually, in the reciprocal duplicate Ratio of their Distances; the said Corpuscle thus placed any where within the Concavity, will not be attracted at all, but every where remain in a state of Rest or Æquilibrio.*

P. 54

PROP. XXIV. *The Time in which a Body let fall from any given Altitude within the Surface, would come to the Centre of the Earth, and ascend again to the same Altitude on the other Side; that is, the whole Time of such an Oscillation, as supposed in the foregoing Corollary, is equal to the semi-periodical Time of a Body revolving about the Earth, at the Distance of one Semidiameter, and retain'd in its Orbit by the sole Force of Gravity, such as it obtains at the Earth's Surface.*

P. 57

PROP. XXV. *The Time in which a Pendulum of any given Length will perform its Vibration, is equal to the semi-periodical Time of a Body revolving by the Force of Gravity in an Orbit, whose Radius or Semidiameter is equal to the Length of the Pendulum.*

P. 59

PROP. XXVI. *The Space thro' which a heavy Body will descend perpendicularly, during the Time that a given Pendulum performs its Vibration, is to half the Length of the Pendulum, in the duplicate Ratio*

d 2

of

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- of the Circumference to the Diameter.* p. 60
- PROP. XXVII. *If a large Sphere or Globe, such as the Earth, be made to revolve about its Axis while it is in a state of Fluidity, it will by such a Motion acquire the form of an oblate Spheroid; in which the Proportion of its Axis to its æquatorial Diameter, will be as the Length of a Pendulum vibrating Seconds at the Æquator, to the Length of a Pendulum vibrating in the same Time at the Poles.* p. 62
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- PROP. XXXI. *All the physical sensible Effects that can proceed from such a Cause of Attraction, and Perturbation of Motion in our Ocean and Atmosphere, must be owing to the Sun and Moon; and all the other Planets and Fix'd Stars are wholly to be rejected, and left out of the Account in the present Case.* p. 73
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- PROP. XXXIII. *These Perturbations of the Ocean and Atmosphere must necessarily be impress'd upon the Blood and animal Fluids, and produce very sensible and*

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*and considerable Effects in animal Bodys.* p. 76

PROP. XXXIV. *Besides the general Force of Gravity, or the Weight of Bodys, as explain'd and apply'd in the foregoing Propositions, the very small Particles of Matter, which constitute the larger Masses, are endu'd with a strong attractive Force, which exerts itself only at, or extremely near the Points of Contact; and vanishes at any greater Distance: which Force or Power of Attraction, to distinguish it from that of Gravity, may be call'd the Force of COHESION; it being that Force by which the small Parts of Bodys unite and cohere among themselves.* p. 82

PROP. XXXV. *Elementary Fire and Air act and re-act mutually upon each other: that is, the Air is expanded and rarefy'd by Heat, which is the Action of Fire; and Fire is excited and put into its most violent and rapid Motion, by the Expansion of the Air.* p. 90

PROP. XXXVI. *The attractive cohesive Power of the small Parts of Matter, as explain'd at Prop. 34. is the universal Principle of Rest, Concretion, and Fixation in Bodys; and the expansive Force of heated Air, or the mutual conjunct Action of Fire and Air, as in the last Proposition, is the universal Principle or natural Cause of Fermentation, Dissolution, and Fluidity.* p. 93

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PROPOSITION I. *The Blood-Globules are specifically heavier than the Serum, and consist of Particles, which*

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*which are endu'd with a stronger corpuscular Attraction, and which receive and retain a greater degree of Heat.* p. 107

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PROP. III. *To find the absolute and relative Velocity of the Blood.* p. 117

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PROP. VIII. *To explain the Nature and Use of animal Secretion.* p. 161

PROP. IX. *The continual Passage of the Blood thro' the small capillary Arterys, and of the Serum thro' the minute glandular Tubuli, is the great Principle of Attenuation in the animal Oeconomy, by which the Blood and animal Fluids have their Parts most minutely broken, separated, and kept from coagulating, or running into large concreted Masses.* p. 181

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*Just Publish'd the following Books, sold by J. OSBORN  
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*Philo-*



*Philosophical Principles*  
O F  
M E D I C I N E.

---

P A R T I.

---

Containing a Demonstration of the  
general LAWS of GRAVITY; with  
their Effects upon Animal Bodys.

---

L A W S of M O T I O N.

L A W I.



ALL Bodys will for ever continue  
in their State of Rest, or uni-  
form direct Motion, unless they  
are compell'd to change that  
State by some external im-  
press'd Force.

B

LAW

## 2 *A Demonstration of the*

LAW 2. The Alteration of Motion is ever proportional to, and in the same given Direction with the impress'd Force that causes it.

LAW 3. Re-action is ever equal, and contrary to Action; or the mutual Actions of any two Bodys upon each other are always equal, and in contrary Directions.

### PROPOSITION I.

*THE Quantitys of Motion, or vires motrices in all moving Bodys, are, as the Quantitys of Matter and Velocitys conjunctly.*

FOR if the Velocitys are equal, 'tis manifest that the Quantitys of Motion, or moving Forces, will be as the Quantitys of Matter; and if the Quantitys of Matter are equal, the Motions will be as the Velocitys: therefore universally, the Quantitys of Motion are in the compound Ratio of both, or as the Quantitys of Matter multiply'd into the Velocitys.

### PROPOSITION II.

*IN all moving Bodys, the Spaces describ'd are as the Velocitys multiply'd into the Times of their Description.*

FOR the Velocitys being equal, the Spaces describ'd must be as the Times; and the Times being equal, the Spaces are as the Velocitys: therefore universally, the Spaces describ'd

## general Laws of Gravity. 3

scrib'd will be in the Ratio compounded of the Times and Velocitys.

### PROPOSITION III.

*A BODY will describe the Diagonal of a Parallelogram by two several Forces combin'd, in the same time that it would have describ'd one or the other of its Sides, by one or the other of the two Forces, separately and respectively.*

IN the Parallelogram  $ABCD$  Fig. 1. Suppose a Body at  $A$  would describe the Line  $AC$ , with an equable Velocity, as  $M$  in the Time  $T$ : and the same Line  $AC$ , moving together with the Body, always parallel to itself, and to  $BD$ , would, with a like uniform Velocity as  $N$ , describe the Parallelogram  $ABCD$ , in the same Time  $T$ . 'Tis manifest that the Velocity as  $M$ , in the Direction  $AC$ , and the Velocity as  $N$ , in the Direction  $AB$ , will be as those Lines of Direction  $AC$  and  $AB$  respectively. Draw the prick'd Lines  $mx$  and  $qy$ , parallel to  $AB$ ; and  $eg$  and  $fp$  parallel to  $AC$ : because of the Parallelism, the Triangles  $ACD$ ,  $Aqr$ , and  $Amn$  will be similar; and therefore  $AC:CD::Aq:qr::Am:mn$ . And consequently, while the Body with the Velocity, as  $M$ , is carry'd from  $A$  to  $m$ , the Line  $AC$ , with the Velocity as  $N$ , will be translated into the Position  $eg$ , and the Body will be in the Diagonal at  $n$ ; and when the Line  $AC$  comes to the Position  $fp$ , the Body in the

B 2                      Direction

#### 4 *A Demonstration of the*

Direction  $AC$ , will have describ'd the Space  $Aq = fr$ , and will be found at the Point  $r$  in the same Diagonal : and by the same Necessity, when the Line  $AC$  coincides with  $BD$ , the Body by its own proper Motion will have describ'd the Space  $AC = BD$ , and will be found at  $D$  ; that is, it will describe the Diagonal by both these Forces conjunctly, in the same time that it would have describ'd one or the other of these Sides, by one or the other of these Forces separately and respectively: Which was the thing to be prov'd.

#### COROLLARY I.

FROM hence 'tis plain, that the Forces by which the Sides and Diagonal of a Parallelogram are describ'd, are proportional to, and may consequently be expounded by those Sides, and that Diagonal respectively.

#### COROLLARY II.

FROM hence it likewise follows, that if a Body be held immovable by two equal Forces in contrary Directions, acting from  $A$  to  $D$ , and from  $A$  to  $S$ , it is the same thing as if it was held immovable by three Forces in the Directions  $AB$ ,  $AC$ , and  $AS$  ; because the Forces  $AB$  and  $AC$  are by the Proposition equivalent to, and will produce the same Effect with the Force  $AD$ , or  $AS$  : and consequently one may be substituted in the room, or used instead of the other.

COROL-

COROLLARY III.

FROM hence 'tis farther evident, that if a Body be held immovable by three Powers, those Powers are one to another directly, as the Lines that are drawn parallel to their respective Directions, and terminated at the Points of their mutual Concourse. For by *Coroll. 1.* the Powers acting in the Directions AD, AB, AC, are proportional to those Lines AD, AB, AC, respectively; that is, as the Lines parallel to the Directions, and terminated at their common Intersection.

PROPOSITION IV.

*IF a Body be continually urg'd or impell'd by any given Force, acting upon it incessantly and without Intermission, the Motion thence arising will be uniformly accelerated; in which Case the Velocitys will be ever as the Times, and the Spaces described as the Squares of the Times, or the Squares of the respective Velocitys.*

A BODY at rest being put into motion by one single Impulse, it will, abating external Resistance, continue to move on in a Right Line, and with an uniform Velocity proportional to, and in the same given Direction with the impress'd Force, by LAW 2. But where Motion is communicated not by one single Impulse, but by a continued impression of an equal uniform Force without intermission, the Force impress'd will be as the

B 3                      Times;

## 6 *A Demonstration of the*

Times ; that is, double in a double Time, triple in a triple Time, &c. But the Motion communicated, and the Velocitys thence arising, are proportional, by the same LAW 2. and consequently, the Velocitys, in this Case, will be equably and uniformly accelerated in proportion to the Times : But the Spaces described, are ever in a Ratio compounded of the Times and Velocitys, by *Prop. 2.* And therefore, where the Ratio of the Times and Velocitys is the same, or where the Velocitys are proportional to the Times, as in the present Case, the compound Ratio of the Times and Velocitys, will be the same with the Squares of the Times, or the Squares of the Velocitys respectively : Which was the thing to be proved.

### COROLLARY.

HENCE it follows, that if a Body moves uniformly, with the whole Velocity acquir'd by an accelerated Motion in a given Time, it would describe twice the Space in the same Time, or an equal Space in the same Time, with half that Velocity. For in an accelerated Motion, where the Velocitys flow uniformly with the Times, if the Time be expounded by the Perpendicular of a Right-angled Triangle, the Base will rightly expound the Velocity ; and the Area of the Triangle, the Space described. Thus in the Triangle ACD, *Fig. 1.* if AC expound any whole Time of an accelerated Motion, CD will

## *general Laws of Gravity.* 7

will represent the Velocity acquir'd in that Time; and the Triangle  $ACD$ , the Space described. And if  $Am$ ,  $Aq$ ,  $AC$ , are put for the different Times,  $mn$ ,  $qr$ ,  $CD$ , will be as their different and respective Velocitys; and the Triangles  $Amn$ ,  $Aqr$ ,  $ACD$ , as the Spaces describ'd. But if in the whole Times,  $Am$ ,  $Aq$ ,  $AC$ , the Body should move uniformly with the whole Velocitys  $mn$ ,  $qr$ ,  $CD$ , it would describe the Parallelograms  $Amne$ ,  $Aqrf$ ,  $ACDB$ , which are double the Triangles,  $Amn$ ,  $Aqr$ ,  $ACD$ ; that is, in the same time that a Body with an accelerated Motion describes a given Space, it will describe double that Space with an uniform, constant Velocity, equal to that which was last acquir'd by the Acceleration; and consequently, an equal Space in the same time, with half that Velocity.

### PROPOSITION V.

*THE Gravity or Weight of Bodys is an accelerating Force; and this Gravity or Weight at the Surface, or at equal Distances from the Centre of the Earth, is directly proportional to the Quantitys of Matter contain'd in such Bodys.*

THAT Bodys prefs continually, or tend equally and uniformly to the Centre of the Earth, and consequently, that this Gravity or Weight is an equably accelerated Force, is evident to Sense, as a most undoubted

## 8 *A Demonstration of the*

Matter of Fact : and it likewise farther appears, from the most accurate Observations and Experiments,

FIRST, That the accelerating Velocitys, acquir'd by Bodys in their perpendicular Descent, reckoning from the Beginning of their Motion, are ever as the Times in which they are acquired ; and the Spaces described, as the Squares of the Times.

SECONDLY, That abstracting from the Resistance of the Air, the Space describ'd by the perpendicular Descent of a Body in one Second of Time, is equal to 16,1 *English* Feet ; and for any longer or shorter Time, as the Squares of those Times respectively.

THIRDLY, That the Resistance of the Air being taken off, or allow'd for, the accelerating Velocitys of all Bodys near the Earth's Surface, are exactly equal ; the lightest Bodys descending as swift as the heaviest, and the least as swift as the greatest : the different Magnitudes, Densitys, and particular Figures, Textures, and Constitutions of Bodys, making no manner of difference as to their Velocitys of Descent, which in all Bodys alike are ever equal in equal Times, and proportional to the Squares of those Times. Now since the *Momenta* or Quantitys of Motion, in Bodys whose Velocitys are equal, are as their Quantitys of Matter, by *Prop. I.* and  
since

## *general Laws of Gravity.* 9

since the accelerating Velocitys of all Bodys, descending by the sole Force of their own Weight, are likewise equal, by what has been just now observ'd; 'tis evident, that the absolute *Momenta*, or Quantitys of Motion in all such Bodys, are likewise as their Quantitys of Matter: But these *Momenta*, or absolute Forces of descending Bodys, are nothing else but their absolute Gravitys, by which they press continually, or tend equally and without Intermiſſion to the Centre of the Earth: And therefore, this absolute Force of Gravity or Weight in Bodys, is exactly proportional to their Quantitys of Matter.

### C O R O L L A R Y.

FROM hence it follows, that there are Vacuities or empty Spaces in Bodys. For since in consequence of this Proposition, the Weight of Bodys is proportional to their Quantitys of Matter; and since upon the Supposition of an absolute *Plenum*, the Density of all Bodys must be equal, or an equal Quantity of Matter every where contain'd in equal Spaces; 'tis evident, that upon this Hypothesis, the Weight of Bodys must be ever proportional to their Bulk or Magnitude, and there could be no difference of Specifick Gravity in Bodys; which being most notoriously contrary to Fact, must evidently and demonstratively overthrow that Hypothesis of an absolute *Plenum*, upon which it is founded.

P R O-

## PROPOSITION VI.

*IF a Body moving with an equable Velocity in a given Direction, be at the same Time continually and equally impell'd, drawn, or any ways urg'd to a given Point, without the Line of its uniform Direction; the said Body, by the Composition of these two Motions, will describe a Curve about the given Point of its Central Force; in which the Areas describ'd by Lines drawn from the Centre, will be situated in the same Plane, and ever proportional to the Times of Description.*

FIG. 2. Suppose a Body at A, moving with an uniform Velocity in the Line, or with the Direction A Q, to be continually drawn, impell'd, or some way or other urg'd to the Centre S; 'tis evident, that abstracting from the Force towards S, the Body with the uniform Velocity in the Direction A Q, would describe the equal Spaces AB, B b, &c. in equal Times; and that if it moves the Space AB in the first equal Portion of Time, it would in the second equal Portion of Time describe the Space B b = AB. But let us now suppose the Force towards S to exert itself, not incessantly, but by starts and intervals, at the end of small equal Portions of Time; and since the Body acted only by the single Impulse in the Direction A Q, would at the end of the second Particle of Time be translated to b; let the centripetal Force

*general Laws of Gravity.* 11

Force towards  $S$ , be now imagin'd to draw the Body from  $b$  to  $C$ ; let  $bC$  be drawn parallel to  $SB$ , and  $Cn$  parallel to  $Bb$ , completing the Parallelogram,  $CnBb$ : And suppose the same thing to be done for the third equal Portion of Time, and so on, as long as the Motion is continued. Now in the Parallelogram  $CnBb$ , 'tis plain that the Side  $Bb$  expounds the Motion of the Body in its uniform Direction, arising from the first single Impulse, which is supposed to be continued without Resistance; and the Line  $bC$  represents the Motion of the Body, as it is continually accelerated towards the Center  $S$ : But by *Prop. 3.* a Body acted upon by two distinct Forces  $Bb$  and  $bC$ , which are to each other as the Sides of a Parallelogram, will describe the Diagonal  $BC$ . Likewise, in the third equal Particle of Time, while the Body by its innate uniform Motion would describe the Line  $Cd$ ; and by its renewed Motion towards the Centre, the Line  $dD$ ; it will by the Composition of these Forces describe the Diagonal  $CD$ , &c. Now that the Polygon  $SABCD$ , &c. is concave towards  $S$ , and that it lies in the fix'd or immovable Plane  $SAQ$ , is very evident from the Construction; and that the Triangles  $SAB$ ,  $SBC$ ,  $SCD$ , &c. are equal, may be thus proved: The Triangles  $SBA$ , and  $SBb$  are equal, as having equal Bases, and the same common Altitude; and the Triangle  $SBb$  is equal to  $SBC$ , as standing on the

the same Base  $SB$ , and lying between the Parallels  $Cb$  and  $nB$ : therefore, the Triangle  $SBC$  is equal to  $SAB$ . And in the same manner, the Triangle  $SCD$  may be proved equal to  $SCB$ , &c. that is, the Areas describ'd are equal in equal Times, and consequently always proportional to the Times of their Description. Let now the Times be lessened, and the number of the Sides  $AB$ ,  $BC$ ,  $CD$ , &c. increas'd *in infinitum*; and let the centripetal Force towards  $S$ , be suppos'd to act not by Starts and small Intervals, but incessantly and without Intermiffion, and then the Polygon  $SABCDE$ , &c. will be a Curve, concave towards  $S$ , and lying in the same given Plane  $SAQ$ , in which the Areas will be ever proportional to the Times of Description.

### COROLLARY.

HENCE, if the Areas describ'd by revolving Bodys about a given Point are proportional to the Times, it must follow, That the Point given is the true Centre of Force to which the said revolving Bodys are drawn, impell'd or urg'd, and by which they are retain'd in their Orbit, and kept from flying off in Right Lines. Thus in the same *Fig. 2.* if it be found that the Triangles  $SAB$ ,  $SBC$ , are equal, 'tis evident that  $Cb$  must be parallel to  $SB$ , and consequently that the Force  $Cb$ , or the centripetal Force, is directed to the Point  $S$ .

PRO-

PROPOSITION VII.

*IF a Body revolves in a circular Orbit about the Centre, the centripetal Force generated in a given Time will be ever equal to the Square of the Arch describ'd in the Time given, divided by the Diameter of the Circle.*

IN Fig. 3. the Triangles  $AdC$  and  $deC$  are similar, by 8 *Eucl.* 6. Let  $AC$  the Diameter be call'd  $d$ ,  $Cd$  the Chord  $c$ , and  $Ce$  the versed Sine  $v$ . Then it will be  $d:c::c:v$ ; therefore  $dv = c^2$ , and  $v = \frac{c^2}{d}$ . If another Arch be taken, as  $DC$ , and its Chord call'd  $C$ , its versed Sine  $V$ , and the Diameter as before  $d$ ; it will be by the same Reasoning  $V = \frac{C^2}{d}$ : and 'tis evident that the Case must be the same universally, whether in the same or different Circles; that is, the versed Sine of an Arch will be ever equal to the Square of the Chord of that Arch, divided by the Diameter of the Circle. Now if we suppose the Arches  $DC$ ,  $dC$ , to be infinitely small, 'tis manifest that in that Case, the Chords will coincide with the Arches themselves, and may be reckoned the same; and in this Case the versed Sines, or Subtenses of the Angles of Contact,  $CE = BD$ , and  $Ce = cd$ , will expound the centripetal Forces, or accelerated Motion towards the Centre; and consequently, what has been demonstrated  
of

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of the Chords, will hold good of the Arches, in this their first arising or last vanishing State: that is, the infinitely small Accelerations of the centripetal Forces, will be equal to the infinitely small Arches, divided by the Diameters. But since the Areas described by all revolving Bodys are as the Times, by the last Proposition; and since in a Circle equal Areas must have equal Arches, therefore in this Case, the Arches will be describ'd uniformly as the Times; and the central accelerating Forces are ever as the Squares of the Times, by *Prop. 4.* and consequently as the Squares of the Arches. Therefore, what has been prov'd of the infinitely small Nascent or Evanescent Arches, must likewise hold universally and eternally of all Arches in this case of circular Motion: that is, the centripetal Forces generated in a given Time will be ever equal to the Squares of the Arches divided by the Diameters: Which was to be demonstrated.

### PROPOSITION VIII.

*IF two or more Bodys revolve about a central Body, their centripetal Forces, or accelerating Velocitys towards the Centre, will be ever in a Ratio compounded of the Distances directly, and the Squares of the periodical Times reciprocally: that is, these Forces will be as the Radii or Distances, divided by the Squares of the periodical Times.*

LET

# *general Laws of Gravity.* 15

LET the greater Radius or Distance be call'd  $R$ , and the lesser  $r$ ; the Arch describ'd in the greater  $A$ , in the lesser  $a$ ; the centripetal Force at the greater Distance  $C$ , at the lesser  $c$ ; the respective periodical Times  $P$ , and  $p$ ; and let the Ratio between the Circumference and Diameter be  $e$ : then will  $2 R e$  be the greater Circumference, and  $2 r e$  the lesser; and in consequence of what has been demonstrated in the last Proposition,  $\frac{A^2}{2R} = C$ , and  $\frac{a^2}{2r} = c$ ; therefore  $A^2 = 2 R C$ , and  $A = \sqrt{2 R C}^{\frac{1}{2}}$ : and for the same Reason  $a = \sqrt{2 r c}^{\frac{1}{2}}$ . Now 'tis evident that the Circumference divided by the Arch describ'd in a given Time will be equal to the whole periodical Time, taken in Parts of the same Denomination with those, which the said Arch is supposed to be describ'd in; and therefore  $\frac{2 R e}{A} = P$ , and  $\frac{2 r e}{a} = p$ . But  $\sqrt{2 R C}^{\frac{1}{2}} = A$ , and  $\sqrt{2 r c}^{\frac{1}{2}} = a$ , by what has been already proved: Therefore, by substituting  $\sqrt{2 R C}^{\frac{1}{2}}$  for  $A$ , and  $\sqrt{2 r c}^{\frac{1}{2}}$  for  $a$ ; it will be  $\frac{2 R e}{\sqrt{2 R C}^{\frac{1}{2}}} = P$ , and  $\frac{2 r e}{\sqrt{2 r c}^{\frac{1}{2}}} = p$ ; and squaring the last Equations, it will stand thus,  $\frac{2 R e^2}{C} = P^2$  and  $\frac{2 r e^2}{c} = p^2$ ; therefore  $\frac{2 R e^2}{P^2} = C$ , and  $\frac{2 r e^2}{p^2} = c$ ; consequently

2

$2 R e^2$

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$\frac{2 R e^2}{P^2} : \frac{2 r e^2}{p^2} :: C : c$ . And dividing by  $2 e^2$ ,

$\frac{R}{P^2} : \frac{r}{p^2} :: C : c$ , or  $R p^2 : r P^2 :: C : c$ ;

That is, the centripetal Forces are in the compound Ratio of the Radii or Distances directly, and the Squares of the periodical Times reciprocally, or as the Distances divided by the Squares of the periodical Times.

PROPOSITION IX.

*FROM the Law of the periodical Times given, to find the Law of the centripetal Force universally.*

IN consequence of what has been demonstrated in the last Proposition, and to avoid the repetition of the different Symbols, we may say in general, that the centripetal Force is ever as  $\frac{r}{p^2}$ ; from which general expression, if the Law of the periodical Times with respect to the Distances be given, by substituting that general Ratio in the room of  $p^2$ , the Ratio, or general Law of the centripetal Force, will presently appear.

THUS in the first place, if the periodical Times are equal, the Ratio of  $p^2$  will be a Ratio of equality; and  $\frac{r}{p^2}$  will be equivalent to  $\frac{r}{1}$ : that is,

THE-

**T H E O R E M I.**

IF the periodical Times are equal, the centripetal Forces will be as the Radii directly.

IF the Squares of the periodical Times are as the square Roots of the Distances; by substituting  $r^{\frac{1}{2}}$  for  $p^2$ , the Ratio  $\frac{r}{p^2}$  will be equivalent to  $\frac{r}{r^{\frac{1}{2}}}$  or  $r^{\frac{1}{2}}$ : that is,

**T H E O R E M II.**

IF the Squares of the periodical Times are as the square Roots of the Distances, the centripetal Forces will be in the same subduplicate Ratio of the Distances.

IF the Squares of the periodical Times are as the Distances, then substituting  $r$  for  $p^2$ , the Ratio  $\frac{r}{p^2}$  will be the same with  $\frac{r}{r}$ , which is a Ratio of Equality. Therefore,

**T H E O R E M III.**

WHEN the Squares of the periodical Times are as the Distances, the centripetal Forces will be equal.

IF the periodical Times are as the Squares of the Distances, and consequently the Squares of the periodical Times in the biquadratick Ratio of the Distances; in this case putting  $r^4$  for  $p^2$ , the Ratio  $\frac{r}{p^2}$  will be the same with  $\frac{r}{r^4}$ , or  $\frac{1}{r^3}$ ; that is,

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T H E O

## T H E O R E M IV.

WHERE the periodical Times are as the Squares of the Distances, the centripetal Forces will be in the inverse triplicate Ratio of those Distances, or as the Cubes of the Distances reciprocally.

BUT if the Squares of the periodical Times are as the Cubes of the Distances, by substituting  $r^3$  for  $p^2$ , the Ratio  $\frac{r}{p^2}$  will be express'd by  $\frac{r}{r^3}$ ; that is,  $\frac{1}{r^2}$ : *i. e.*

## T H E O R E M V.

WHEN the Squares of the periodical Times are as the Cubes of the Distances, the centripetal Forces or accelerating Velocitys towards the Centre, will be as the Squares of the Distances reciprocally.

AND thus may the same Principle, or general Law, be apply'd universally to any particular Case, to discover the Law of the centripetal Force, from the Law of the periodical Time given.

## P R O P O S I T I O N X.

*THE Velocitys of Bodys revolving about a given Centre at different distances, are universally as the Distances directly, and the periodical Times reciprocally; or, which is the same thing, directly as the Radii divided by the periodical Times.*

F O R

FOR if the periodical Times are equal, the Velocitys will be as the Radii or Distances; that is, as the Peripheries, which are the Spaces described. But if the Distances are equal, 'tis plain that the Velocitys must be reciprocally as the periodical Times: Therefore universally, the Velocitys will be in the Ratio compounded of both these; that is, the Distances directly, and the periodical Times inverfly, or as the Distances divided by the periodical Times.

SCHOLIUM I.

SINCE in consequence of this Proposition the Velocitys are ever as  $\frac{r}{p}$ , where  $r$  stands for Radius or Distance, and  $p$  for periodical Time; we have hereby a general Canon to determine the Ratio of the Velocitys, from the Law of the periodical Times given, as has been done with respect to the centripetal Forces at *Prop. 9*. Thus suppose the Squares of the periodical Times to be as the Cubes of the Distances, and consequently the periodical Times themselves in the sesquialterate Ratio of the Distances, or as  $r^{\frac{1}{2}}$ ; then in the general expression for the Velocity  $\frac{r}{p}$  in the place of  $p$ , substituting its equivalent  $r^{\frac{1}{2}}$ , it will be  $\frac{r}{r^{\frac{1}{2}}}$  or  $r^{\frac{1}{2}}$ : that is, where the periodical Times are in the sesquialterate of the Distances, the Velocitys will be as the square Roots of the Distances reciprocally.

## S C H O L I U M II.

WHAT has been said here about Velocitys and centripetal Forces, compar'd with the Distances, must be understood of the middle Distances and mean Velocitys, where the Bodys revolve not in circular but in elliptical Orbits, about one of the Foci. 'Tis commonly known that every Ellipsis is equal to a Circle, whose Diameter is a mean Proportional between the transverse and conjugate Diameters; at which distance, a Body moving in an Ellipsis obtains its mean Velocity, and would perform its revolution in the same Time as before: from whence 'tis plain, that what is demonstrated of Bodys moving in Circles, concerning the Laws and Proportions of their Velocitys, periodical Times and centripetal Forces, must hold good also in Ellipses, with respect to these mean Distances.

## P R O P O S I T I O N XI.

*THE primary Planets revolve about the Sun, the Moon about the Earth, and the Satellites of Saturn and Jupiter about Saturn and Jupiter, as their true and proper Centres: And the Law of their Revolution is such, that the Squares of their periodical Times are as the Cubes of the Distances from their different and respective Centres.*

THIS Proposition is matter of Fact and Experience; and therefore it will be a sufficient

## general Laws of Gravity. 21

cient demonstration of it, to set down here the periodical Times and proportional Distances, as they are observ'd and computed by the best modern Astronomers.

THE periodical Times of the primary Planets about the Sun, and their proportional Distances from the Sun's Centre, are as follows :

		d.	h.	'		
SATURN	revolves about the S U N in the Space of	10759	06	36	Proportional distances from the Centre of the S U N.	953806
JUPITER		4332	12	20		520116
MARS		686	23	27		152399
The EARTH		365	06	09		100000
VENUS		224	16	49		72333
MERCURY		87	23	16		38710

SATURN has five Satellites or secondary Planets revolving about him, whose periodical Times and proportional Distances are thus determined :

		<i>d.</i>	<i>h.</i>	<i>'</i>	<i>"</i>		
The first	revolves in the space of	1	21	18	26	Proportional Distances.	181
The second		2	17	41	10		231
The third		4	12	25	10		323
The fourth		15	22	41	28		749
The fifth		79	07	46	00		2182

THE four Satellites of *Jupiter* revolve about him in the periodical Times, and at the proportional Distances following :

		d.	h.	'	"	
The first	revolves in the Space of	1	18	27	36	Propor. D.
The second		3	13	13	42	
The third		7	3	42	36	
The fourth		16	16	32	09	
						292
						454
						725
						1276

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THE Moon revolves about the Earth at the mean Distance of 60 of the Earth's Semidiameters; each Semidiameter containing 3984 *English* statute Miles.

Now whoever will compare the proportional Distances with the respective periodical Times, will find that the Times are every where in the sesquialterate Ratio of the Distances; which demonstrates the truth of the Proposition.

### S C H O L I U M.

THE foregoing proportional Parts are all taken upon the same Scale, and are to be understood of such parts, of which the Distance of the Earth from the Sun contains 100000. But the reduction of these to any known assignable Measure, depends upon the Sun's Parallax, or the Angle which the Semidiameter of the Earth would subtend to an Eye at the Centre of the Sun: and according to the best and most accurate Observations hitherto made, by comparing the Parallax of the Earth with that of *Mars* and *Venus*, this parallaxick Angle of the Sun at the Earth is about 11''; with which Measure of the Sun's Parallax, as coming very near the truth, we may rest satisfy'd, till some more favourable Phænomenon hereafter shall give the Astronomers an opportunity of determining this matter, to the greatest nicety and exactness.

Now the Parallax being taken as here 11'', each of the foregoing proportional parts will

## *general Laws of Gravity.* 23

contain 747 *English* statute Miles: and therefore, if those proportional Distances are respectively multiply'd by 747, they will be reduced to such Miles. Likewise the Semidiameter of the Earth contains  $5\frac{1}{3}$  of such proportional parts; and consequently, if those proportional Distances are singly and respectively divided by  $5\frac{1}{3}$ , they will be reduced to Semidiameters of the Earth.

AND because the middle Distance of the Moon from the Earth, is 60 of the Earth's Semidiameters, and each Semidiameter contains  $5\frac{1}{3}$  of the aforesaid proportional parts; therefore the Distance of the Moon from the Earth is 320 such proportional parts, of which the Distance of the Earth from the Sun contains 100000.

### PROPOSITION XII.

*LET two or more Bodys be supposed to revolve about the Earth at different Distances, and to be retain'd in their Orbits by their Weight, or accelerating Forces towards the Earth's Centre; and I say, that the Law of their Revolution will be such, that the periodical Times will be in the Jesquialterate Ratio of the Distances; or the Squares of the one, as the Cubes of the other.*

THE Earth having but one single Satellite or secondary Planet, the Moon revolving about her, we cannot here compare the Motions of any two Bodys actually revolving and

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respecting the Centre of the Earth, as has been done with respect to the *Sun*, *Saturn*, and *Jupiter*. But since we know in fact, that the accelerating Velocity of all Bodys near the Earth's Surface, is after the rate of 16,1 *English* Feet in the first Second of Time; it will be easy from hence to determine the periodical Time of a Body revolving near the Surface, or at the Distance of one Semidiameter, and retain'd in its Orbit by this common Acceleration towards the Center.: To which purpose, let  $r$  stand for the Radius or Semidiameter of the Earth,  $2\pi r$  for the Circumference,  $c$  for the accelerating Velocity at the Surface 16,1 Feet, and  $p$  for the periodical Time. Then by what has been demonstrated at *Prop.* 8. it will be  $\frac{2\pi r}{c} = p^2$ ; that is, the Circumference of the Earth in Feet, multiply'd by the Ratio between the Circumference and Diameter, and divided by 16,1, the accelerating Velocity generated in one Second, will give the Square of the periodical Time in Seconds: from which extracting the square Root, and dividing by 60, we shall have the periodical Time in Minutes. From this Computation, the periodical Time of a Body thus revolving, will be found  $= 84\frac{2}{3}$  Minutes nearly.

Now the Moon, at the distance of 60 Semidiameters, revolves about the Earth in the Space of 39343 Minutes. But  $84\frac{2}{3}$  and 39343, are in the sesquialterate Ratio of the Distances  
1 and

## *general Laws of Gravity.* 25

1 and 60 ; or the Squares of the one, as the Cubes of the other : which was the thing to be proved.

### PROPOSITION XIII.

*THE centripetal Forces, or accelerating Velocitys of the Moon to the Earth, of the primary Planets to the Sun, and of the Satellites of Saturn and Jupiter, to Saturn and Jupiter respectively ; are universally in the reciprocal duplicate Ratio of the Distances from their different and respective Centres.*

FOR the Squares of the periodical Times are ever as the Cubes of the Distances, by the two last Propositions ; but where the Squares of the periodical Times are as the Cubes of the Distances, the centripetal Forces will be as the Squares of the Distances inverfly, by *Prop. 9. Theorem 5* ; and therefore the centripetal Forces or accelerating Velocitys of those revolving Bodys, towards their proper and respective Centres, must be ever in the reciprocal duplicate Ratio of the Distances, or as the Squares of the Distances inverfly.

### PROPOSITION XIV.

*THE accelerating Velocitys of any two Bodys towards each other, are reciprocally as the Bodys themselves, or directly as the Quantitys of Matter in the attracting Bodys to which the Acceleration is made.*

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SUPPOSE two Bodys, A and B, mutually attracted by, or gravitating towards each other; and let  $a$  express the accelerating Velocity of A towards B, and  $b$  the accelerating Velocity of B towards A. Now Re-action being ever equal and contrary to Action, 'tis evident that the *Momentum motus* of A towards B, must be equal to the *Momentum motus* of B towards A; that is,  $Aa = Bb$ : but the *Momenta* of Bodys, are universally as the Quantities of Matter multiply'd into the Velocities, by *Prop.* 1. therefore, if  $a$  and  $b$  express the Velocities, A and B will expound the Quantities of Matter respectively. And because  $Aa = Bb$ ; therefore,  $A : B :: b : a$ ; and  $A : b :: B : a$ : that is, the Quantity of Matter in A, is to the Quantity of Matter in B, as the accelerating Velocity of B towards A, to the accelerating Velocity of A towards B.

C O R O L L A R Y.

FROM hence it follows, that at equal Distances, the Quantities of Matter in all Bodys considered as central and attracting, are as the accelerating Velocities towards them. For in this Proposition, the Distance of B from A, and of A from B, is the same; and the Quantities of Matter are as the accelerating Velocities towards those Bodys directly: but by *Prop.* 13. the accelerating Velocities of all Bodys towards the same Centre, are equal at equal Distances; therefore the Quantities of Matter in all Bodys, are as the accelerating Velo-

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Velocities towards them, where the Distances are equal.

PROPOSITION XV.

*THERE is in all Bodys, and the several Parts of which they are composed, a mutual Attraction, Gravitation, or Conatus mutuò accedendi; which Force is of the same nature and kind with that which we call GRAVITY or Weight, by which Bodys tend to the Centre of the Earth; and is ever in a Ratio compounded of the Quantitys of Matter in the Bodys themselves directly, and the Squares of their Distances reciprocally.*

THAT these attracting or gravitating Forces at the same or equal Distances, are as the Quantitys of Matter in the Bodys themselves, has been proved in the last Proposition; and with respect to the same central or attractive Body, the centripetal Forces are as the Squares of the Distances reciprocally, by *Prop. 13*. Therefore universally, those Forces must be in a Ratio compounded of both these, or as the Quantitys of Matter directly, and the Squares of the Distances reciprocally. Now that this Force is universal, and equally affects the Sun, the Earth, the Moon, and all the primary and secondary Planets, is evident from what has been hitherto demonstrated: but since the Weight of Bodys here with us, is an accelerating Force; and at the Earth's Surface, or equal Distances from the Centre, as  
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the Quantitys of Matter in the Bodys themselves, by *Prop.* 5. and since also the periodical Time of a Body revolving about the Earth, at the Distance of one Semidiameter, and retain'd in its Orbit by its own Gravity or Weight, would be to the periodical Time of the Moon revolving likewise about the Earth, in the sesquialterate Ratio of the Distances, by *Prop.* 12. which is the same Law that has been prov'd to obtain, with respect to the primary Planets about the Sun, and the Satellites of *Saturn* and *Jupiter* about their primary ones: 'tis plain from hence, that this Force is of the same nature and kind with the Gravity or Weight of Bodys, obtaining universally thro'out the whole Solar System, and acting according to the general Law which has been here demonstrated.

### COROLLARY.

FROM hence it follows, that the Earth revolves, as a Planet, annually about the Sun; and consequently, that the Sun remains fix'd, as the true and proper Centre of the whole System. For,

SUPPOSING the Earth to revolve about the Sun, its periodical Time and Distance will exactly correspond to the Length of our solar Year, according to the general Law of Nature, by *Prop.* 11. that is, the periodical Time of the Earth, compared with those of the other primary Planets, will be precisely in the sesquialterate Ratio of the Distances.

But

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But if the Sun revolves by its Gravitation to the Earth as its Centre, as the Moon most certainly does ; the periodical Time must be 413 times greater than it now is, and the solar Year in that case must contain 413 of our present solar Years : that is, supposing the Sun's Parallax to be 11 seconds ; which agrees to the best Observations. But if the Sun upon this Hypothesis be brought so near the Earth, as to make the present solar Year agree to the periodical Time of the Moon, with respect to the Earth as their Centre ; the Sun's Parallax in this case must be increased to about 10 Minutes : whereas all Observation assures us, that it cannot exceed the fourth part of a Minute. So that the Rest of the Sun in the Centre of the whole System, and the annual Motion of the Earth, is now no longer an Hypothesis, but a Matter of Demonstration.

### S C H O L I U M.

IT must be here observed, to prevent the Mistakes which some have run into, that these Terms, *Attraction* and *Gravitation*, are not intended to express either the absolute Nature, or physical Cause of the Forces themselves, but only the Quantity and Direction of the Motion generated and produced by them. 'Tis certain fact, that Gravity, whether we consider it at the Surface of the Earth, or any where else, is an accelerating Force capable of producing a given Quantity  
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of Motion, in a given Time, according to the general Law; which has been demonstrated in this Proposition. And this must necessarily hold good, whatever the absolute Nature or physical Cause of Gravity be. Some people pretending to Philosophy, not adverting to this, have blunder'd most egregiously in their Objections against the *Newtonian* Principles; as if the Causes of Motion there assign'd, were impossible, absurd, and unintelligible. These Objections are mainly grounded upon an Imagination, that the illustrious Author supposes the Gravity or Weight of Bodys to be an essential and intrinsic Power or Property in the Bodys themselves; or the mere result of Matter acting upon Matter: whereas he ever supposes, and frequently in express terms declares the contrary.

BUT I hope these mechanical Gentlemen, who seem unwilling to admit any thing but Matter and Motion in the World, will not therefore renounce their Senses, and deny that there is any such Force in Nature, as the Weight of Bodys; because they find themselves at a loss perhaps, in assigning the Origination and physical Cause of this Force.

THE wonderful and incomparable Author of the *Principia*, has at least given as good an Account of the Cause of Gravity as any body else; and therefore, if the Case should be such, that it could not be fairly accounted for at all, it must be very unreasonable to charge this, as a peculiar Difficulty on the *Newtonian* Philo-

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Philosophy. For whether Gravity be an essential intrinsic Property of the Bodys themselves, or the necessary Effect of Matter acting upon Matter; or lastly, the Action of some intelligent Cause: yet still the *Newtonian* Philosophy must hold good, and may be supported upon either of these Suppositions; since this Philosophy only assumes upon Demonstration, this Power or Principle of Gravity, as universal in fact, and from thence demonstratively accounts for the actual Phænomena of Nature.

THOSE who cannot agree with the great Author, that the Gravity or Weight of Bodys is a Force impress'd upon the whole material System, and continually exerted in one constant uniform Law, by the first Cause, or God himself; are at liberty, no doubt, to account for the Causes of Things without a first Cause, as well as they can.

BUT then they must either come in fine to a first Cause, or else run their Accounts *in infinitum*, and suppose every thing to be Effect, without Cause; or without any active Power or Principle in Nature, of beginning and continuing Motion.

BUT if they must in the issue come to some first intelligent Cause, perhaps the sooner the better: for why should they give themselves the trouble of creating an infinite number of imaginary Causes, to no purpose; and go a vast way about, to come at last to the same place, or possibly never to come to any result at all?

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IN the mean while, those who shall endeavour to account for Gravity, otherwise than by resolving it into the continued Action of the first Cause upon the whole material System, may perhaps keep far enough from Religion, and take sufficient care, that *God is not in all their thoughts*; but will never, I fear, be able to advance any thing that is true, or consistent in Philosophy.

UPON the whole, the only true and right Method of reasoning about natural Causes and Effects, is undoubtedly this, which the divine *Newton* has admirably exemplify'd; namely, to establish in the first place, some very certain and most obvious Principles, such as may be evident in fact; and by a right application of these, to proceed to the more remote, and less obvious Springs and Movements of Nature.

BY this means, if we cannot come to know all that we would, we shall at least obtain a great deal of useful Knowledge, such as will better pay the Expence, than mere arbitrary Hypotheses, and imaginary Schemes, which have nothing to support them, but Ignorance and Presumption.

### PROPOSITION XVI.

*THE absolute central Forces, or Quantities of Matter in attracting Bodys, are universally in the triplicate Ratio of the Distances of revolving Bodys from those Centres directly, and the duplicate Ratio of the periodical Times inversely:*

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*versly: that is, those Forces, or Quantitys of Matter, are ever as the Cubes of the Distances, divided by the Squares of the periodical Times.*

FOR if  $r$  be put for Radius, or Distance in general, the centripetal Forces will be universally as  $\frac{r}{p^2}$ , by *Prop. 8.* And in this case, where the Distances are equal,  $r$  will be a standing Quantity; and consequently, the Ratio of  $\frac{r}{p^2}$  will be the same with  $\frac{1}{p^2}$ , or the reciprocal duplicate Ratio of the periodical Times. But the Distances being equal, the centripetal Force will be as the absolute central Forces, or Quantitys of Matter in the attracting Bodys, by *Prop. 14.* and its *Corollary.* Therefore, those Quantitys of Matter at equal Distances will be as  $\frac{1}{p^2}$  or  $\frac{r}{p^2}$ : but the Cubes of the Distances increase or decrease as the Squares of the periodical Times, by *Prop. 11.* and therefore at all Distances, the Ratio of  $\frac{r^3}{p^2}$ , will be the same with the Ratio of  $\frac{1}{p^2}$  or  $\frac{r}{p^2}$ , at equal Distances; that is, as the Quantitys of Matter: And consequently at all Distances, putting  $r$  for the variable Distance, and  $p$  for the periodical Time in the revolving Bodys; the Quantitys of Matter in the central attracting Bodys will be ever as  $\frac{r^3}{p^2}$ ; or as the Cubes of the Dis-

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tances directly, and the Squares of the periodical Times reciprocally, according to the Proposition.

### PROPOSITION XVII.

*THE Densitys of all central attracting Bodys, are ever in the compound reciprocal Ratio of the Cubes of the Parallaxes of the Bodys revolving about them, multiply'd into the Squares of their respective periodical Times.*

To demonstrate this, it must be observ'd in the first place, that the Densitys of Bodys are ever as their Quantitys of Matter, divided by their Magnitudes: for if the Magnitudes are equal, the Densitys will be directly as the Quantitys of Matter; and the Quantitys of Matter being equal, the Densitys must be reciprocally as the Magnitudes: therefore they will be universally in the Ratio compounded of both, or as the Quantitys of Matter divided by the Magnitudes.

It must be observed farther, that the real Diameters of Bodys are as their apparent Diameters multiply'd into their Distances. For if the Distances are equal, 'tis evident the real Diameters will be as the apparent Diameters, or as the Angles subtended by those Diameters themselves: but if the apparent Diameters are equal, the absolute or real Diameters will be as the Distances. Therefore universally, the real Diameters will be in the Ratio compounded of the apparent Diameters and the Dis-

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Distances. Consequently, if  $d$  be put for Distance, and  $m$  for apparent Diameter, the real Diameters will be ever as  $m d$ : but 'tis well known, that the Magnitudes of Spheres are as the Cubes of their Diameters; and therefore, where the Diameters are as  $m d$ , the Magnitudes will be as  $m^3 d^3$ . But the apparent Diameter of any given central Body at the Distance of its revolving Body or Satellite, is equal to twice the Parallax of that revolving Body; therefore the Magnitudes, which are in the triplicate Ratio of the apparent Diameters and Distances, will likewise be in the triplicate Ratio of those same Distances, and these Parallaxes, which are the apparent Semidiameters: that is, putting  $l$  for the general Expression of Parallax, and  $d$  as before for Distance, the Magnitudes will be as  $d^3 l^3$ . Now by the last Proposition, the Quantities of Matter are ever as the Cubes of the Distances divided by the Squares of the periodical Times; or putting  $d$  for Distance, and  $p$  for periodical Time, the Quantities of Matter will be as  $\frac{d^3}{p^2}$ : and since the Densities are universally as the Quantities of Matter divided by the Magnitudes, therefore  $\frac{d^3}{p^2}$ , the general Expression for the Quantity of Matter, being divided by  $d^3 l^3$  the general Ratio of the Magnitudes, the Quote will be  $\frac{1}{l^3 p^2}$ ; which is the general Expression for the Ratio

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of the Densitys : that is, the Density will be ever in the Ratio compounded of the Cubes of the Parallaxes, and the Squares of the periodical Times, reciprocally.

#### SCHOLIUM.

FROM what has been demonstrated in these two last Propositions, the Diameters and Magnitudes of the Sun and Planets, together with the proportional Quantities of Matter, and Densitys of all such Bodys as have other Bodys revolving about them, may be easily determin'd.

FOR since the apparent Diameters of the Planets, at their proper and respective Distances from the Sun, are given by astronomical Observation; namely, that of *Saturn* 18'', of *Jupiter* 40'', of *Mars* 8'', of the *Earth* 22'', of *Venus* 28'', and of *Mercury* 20''. And since their proportional Distances from the Sun are likewise given as before shewn at *Prop.* 11. therefore, by what has been demonstrated in this Proposition, these apparent Diameters multiply'd by the respective proportional Distances, will give the Ratio of the real Diameters : and because the Diameter of the Earth is given in a known Measure, namely 7968 *English* Miles, the Diameters of the Sun and Planets will be likewise given in the same Miles. According to which Computation, the Sun's Parallax being supposed as here 11'', and the Diameter of the Earth 7968 *English* Statute Miles;

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Miles ; the Diameter of the Sun will be 700000, of *Saturn* 62150, of *Jupiter* 75300, of *Mars* 4414, of *Venus* 7250, of *Mercury* 2800, and of the *Moon* 2180 such Miles. And Spheres being as the Cubes of their Diameters, if the Magnitude of the Earth be put equal to Unity, that of the Sun will be as 681500, of *Saturn* 474, of *Jupiter* 844, of *Mars*  $\frac{1}{6}$ , of *Venus*  $\frac{3}{4}$ , of *Mercury*  $\frac{1}{3}$ , of the *Moon*  $\frac{4}{125}$ .

AND by pursuing the Computation for the Quantities of Matter and Densities of such Bodys in the Solar System, as have other Bodys revolving about them ; it will appear, that if the Quantity of Matter in the Earth be taken as 1, that of the Sun will be as 170000, of *Saturn* as 49, of *Jupiter* as 154.

AND for the Densities ; supposing the Density of the Sun as 100, that of the Earth will be as 400, of *Jupiter* as 73, and of *Saturn* as 33.

IT may be observed here, that the Quantity of Matter in the Moon, is to the Quantity of Matter in the Earth, as 1 to 40 ; and the Density of the Moon, to that of the Earth, as 5 to 4 nearly : which cannot indeed be deduced from the foregoing Propositions, but will be demonstrated afterward upon another Principle, and in its proper place.

Now by comparing these Proportions, it will appear, that the Densities of the primary Planets are nearly in the reciprocal Ratio of  

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their Distances from the Sun. And since this Proportion appears so remarkable, and with so little Variation in the Earth, *Jupiter* and *Saturn*, which having other Bodys revolving about them, admit of demonstrative Calculation, as above; 'tis reasonable enough to suppose from the Analogy, Uniformity and Simplicity of Nature, that the same Proportion obtains likewise with respect to *Mars*, *Venus* and *Mercury*: and tho for want of any discoverable Satellites or secondary Planets revolving about these latter, the thing cannot be determined with certainty and to a Demonstration; yet, where Nature is found to keep to some certain general Law, so far as our Inquirys and Observations can reach, 'tis very reasonable to conclude, that the same Law obtains also still farther, and where the like Observations cannot be made.

Now this being admitted or supposed, the Quantitys of Matter, and Denfitys of the Sun and Planets, taken all together, will be as here set down.

	Quantitys of Matter.	Denfitys.
The SUN	170000	100
SATURN	49	33
JUPITER	154	73
MARS	$\frac{1}{9}$	260
The EARTH	1	400
The MOON	$\frac{1}{32}$	500
VENUS	1	550
MERCURY	$\frac{1}{9}$	1000

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PROPOSITION XVIII.

*IF a Body, as P, revolves about another Body S; that other will likewise revolve about the former; that is, they will both revolve in the same Time about their common Centre of Gravity: and the Figures described about the common Centre of Gravity, and about each other mutually, will be respectively similar.*

SUPPOSE two Bodys, S and P, *Fig. 4.* to attract or tend to each other mutually; and let C be their common Centre of Gravity; then will PC represent or expound the accelerating Velocity of P towards S; and SC the accelerating Velocity of S towards P. Now if P describes the Arch Pp, in a given Time, S must describe the Arch Sf in the same Time about the common Centre C; so that the Arches described Pp and Sf, may be as the accelerating Velocitys, PC and SC; for by that means alone, can the Bodys be retained at a given Distance; which must otherwise approach still nearer and nearer to each other, by their mutual Attraction, till they come to a Contact. But the Figures CPp, and CSf, described by the Bodys P and S, about the common Centre C, are plainly similar: and because CP and CS are in a given Proportion, namely, as S to P; therefore by compounding,  $CP + CS$  will be in the same given Proportion; and the Figure described by P about S, considered as

immovable, will be equal and similar to the Figure described by  $S$  about the Centre  $P$ ; and both similar to the former, namely, in the constant Ratio of the Radii  $CP$ ,  $CS$ , and  $SP$ , or  $fp$ .

### PROPOSITION XIX.

*IF two Bodys,  $S$  and  $P$ , attract or tend to each other mutually, with given Forces, and at the same time revolve about the common Centre of Gravity  $C$ ; I say, that with the same Figures thus described about the common Centre of Gravity, a similar and equal Figure may be described with the same Forces, by either of those Bodys about the other considered as immovable.*

SUPPOSE in the first place, *Fig. 5.* the Orbits  $PR$  and  $SQ$ , to be described about the common Centre  $C$ ; and let  $Pp$  and  $Sf$  be the Arches described in the same Time. Let the Line  $SCp$  be supposed to move parallel to itself till it coincides with the Line  $Sq$ , and the Point  $f$  comes to  $S$ ; and let this be supposed to be done, in all the correspondent Points of the Curves  $SQ$  and  $PR$ . 'Tis plain, that upon the appulse of the Point  $f$  to  $S$ , the other extreme of the Line  $fp$  will be at  $q$ , the Point in the Curve  $Pq$ , to which the Body  $P$  would have come in the same Time, by its Revolution about  $S$ , considered as immovable; and with the same Force, by which the Bodys were before supposed to tend mutually to each other: for the  
parallel

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parallel translation of the Line  $Sp$ , makes no difference or alteration at all of the Forces tending from  $P$  to  $S$ , and from  $S$  to  $P$ . But  $Pq$  is the Arch described in the same Time, by the Body  $P$  about  $S$  as a Centre, and the Line  $Sq$  is of the same Length, and has the same Inclination to the Line  $SP$  with  $Sp$ . These Figures, therefore, being perfectly and exactly correspondent, they must be equal and similar. And what has been here proved of  $P$  moving about  $S$  as a Centre, must for the same Reasons hold good of  $S$  moving about  $P$  as its Centre.

### COROLLARY I.

FROM hence it follows, that if any two Bodys attract, or tend to each other mutually, and revolve about their common Centre of Gravity; they will by Radii drawn from that common Centre, and from each other respectively, describe Areas proportional to the Times.

### COROLLARY II.

FROM hence it likewise follows, that if two Bodys attract each other, and revolve about their common Centre of Gravity; their Motions will be the same as if they did not attract each other mutually, but were both attracted by a third Body placed in the Centre of Gravity, with the same Force by which they attract each other. For in *Fig. 4.* 'tis evident, that the Forces with which the Body  $P$

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P tends to S, are directed to some Point in the Line PS, produced towards S; and likewise the Forces of the Body S are directed to some Point in the same Line, produced towards P: but C is the only Point in the Line SP, which remains immovable in every position of the Bodys S and P; and therefore C is that Point to which the Bodys S and P tend, with the same Forces by which they attract one another.

PROPOSITION XX.

*IF two Bodys attracting each other mutually, revolve about their common Centre of Gravity, the Distances remaining the same; the periodical Time about the Centre of Gravity, is to the periodical Time of one of those Bodys revolving about the other, by the sole Attraction of that other, in the subduplicate Ratio of the fix'd or central Body to the Sum of the Bodys.*

FROM the well-known Property of the Centre of Gravity, the Distances of any two revolving Bodys from that Centre, are reciprocally as the Bodys themselves: but the Bodys themselves, or the Quantitys of Matter contain'd in them, the Distances being equal, are as the centripetal Forces; therefore, the centripetal Forces, in this case of equal Distances, are as the Bodys reciprocally. But by *Prop. 8.* the centripetal Forces are ever in a Ratio compounded of the Distances directly, and the Squares of the periodical Times reciprocally;

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proccally ; and therefore, where the Distances are equal, those Forces are as the Squares of the periodical Times reciprocally ; and consequently the periodical Times as the Square Roots of those Forces reciprocally : that is, reciprocally as the square Roots of the attracting Bodys. But in the Revolution of the Bodys about the Centre of Gravity, both Bodys are supposed to attract ; but where one of the Bodys revolves about the other as a Centre, only the central quiescent Body is considered as attracting. Therefore the periodical Time in the former case, will be to the periodical Time in the latter, as the square Root of the centripetal Force in the latter, to the square Root of the centripetal Force in the former ; that is, in the subduplicate Ratio of the central quiescent Body, to the Sum of the Bodys : Which was to be demonstrated.

### PROPOSITION XXI.

*THE same things supposed as in the last Proposition ; I say, that the periodical Times being equal, the Distance of the Bodys revolving about their common Centre of Gravity, is to the Distance of the same Bodys, where one of them revolves about the other considered as immovable, in the subtriplicate Ratio of the Sum of the Bodys to the fix'd or central Body.*

PUTTING  $r$  for Radius or Distance, and  $p$  for periodical Time, the centripetal Forces are

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are ever as  $\frac{r^3}{p^2}$ , by *Prop.* 16. Therefore  $p$  being every where the same, or the periodical Times equal, the centripetal Forces will be as  $r^3$ : that is, as the Cubes of the Distances; and consequently the Distances as the Cube Roots of the centripetal Forces. But in this case, the centripetal Forces are as the attracting Bodys; and therefore those Forces which are as the Cube Roots of the Distances, will be as the Cube Roots of the attracting Bodys: that is, the Distance in the first case, will be to the Distance in the second, as the Cube Root of the Sum of the Bodys, to the Cube Root of the fix'd or central Body.

## S C H O L I U M.

IT has been shewn at *Prop.* 12. that a Body at the Distance of 60 Semidiameters, would revolve about the Earth, by the sole Attraction of the Earth, in the periodical Time of 39343 Minutes: and this being the periodical Time of the Moon, the Moon's mean Distance has been accordingly there supposed to be 60 of the Earth's Semidiameters. But because the Earth and Moon do in fact and reality revolve mutually about their common Centre of Gravity; and the Quantity of Matter in the Earth, is to the Quantity of Matter in the Moon, as about 40 to 1; therefore their mean Distance will be something more than 60 of the Earth's Semidiameters, in the subtriplicate Ratio of 41 to 40;

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40; and consequently the mean Distance by the whole conjunct Forces of the Earth and Moon, will be  $60\frac{1}{2}$  Semidiameters nearly. But then because the Sun by his Attraction upon the Earth and Moon, does in some measure disturb their Motions, and upon the whole lessen their mutual tendency to each other, as shall be shewn afterward; therefore the true mean Distance in fact, and as determin'd by Observation, is  $60\frac{1}{4}$  of the Earth's Semidiameters: At which distance, the apparent Semidiameter of the Moon, by the exactest Observations, is  $31' 16''$ ; and her horizontal Parallax,  $57' 4''$ .

### PROPOSITION XXII.

*IF a Body revolving about a given Centre, has its Motion disturb'd by the Attraction of some other Body drawing it to a different Centre; 'tis requir'd to find the general Laws and Proportions of the perturbing Forces.*

IN Fig. 6. let S represent the Sun, T a primary Planet, as the Earth revolving about the Sun in the Orbit *ee*; and L a secondary Planet, as the Moon, revolving about T, in the Orbit ABCD. Let ST represent the Attraction of T towards S, and likewise the Attraction of L towards S, at its mean Distance. Take *Sr* to ST, in the duplicate Ratio of ST to SL; and *Sn* to ST, in the same duplicate Ratio of ST to SL: then will *Sr* and *Sn* expound the Attractions of  

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the Body  $L$  towards  $S$ , in the Points  $L$  and  $l$  respectively. Complete the Parallelograms  $MSGr$ , and  $tSgn$ ; then the Force, as  $rS$ , which expounds the Attraction towards  $S$  at the Point  $L$ , will by *Prop. 3.* be resolved into the two Forces  $rM$  and  $MS$ ; and the Force  $nS$ , which expounds the Attraction towards  $S$  at the Point  $l$ , will be resolved into the Forces  $nt$  and  $tS$ .

Now the Forces  $rM$  and  $nt$  being directed as  $LT$  or  $lT$  towards  $T$ , will not at all disturb the Motion of the Body  $L$  about its Centre  $T$ ; but notwithstanding this Force, the Areas described about  $T$ , as a Centre, would be still proportional to the Times, after the same manner, as if the Body at  $L$  or  $l$ , was not attracted at all to the Point  $S$ . But the Forces which are as  $MT$  and  $Tt$ , being the Excess and Defect of the Attractions at  $L$  and  $l$ , with respect to the mean Attraction at  $T$  towards  $S$ , and being directed not to  $T$  as before, but to a different Centre  $S$ , will disturb the Motion of the Body  $L$  about  $T$ : and this Perturbation, in its Effects, will be proportional to the perturbing Forces  $MT$  or  $Tt$ ; which are the sole and adequate Causes of it.

Now 'tis manifest, that when  $SL$  and  $Sl$  is equal to  $St$ , (that is, when the Body  $L$  is in or near the Points  $A$  or  $C$ ;) the Points  $M$  and  $t$  will coincide with  $T$ ; and the Forces, as  $MT$  and  $Tt$ , will vanish, or become equal to nothing. But when  $L$  and  $l$

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coincide with B and D ; that is, in the Conjunction or Opposition of the Satellite with the Sun, the Force, as MT or T *t*, and consequently the Perturbation of Motion towards T, will be greatest. And here it must be observ'd in the first place, that the Forces, as MT or T *t*, being in their mean Quantity equal to LT or l T, will be always given, as being expounded by the Distance of L from T, which is supposed to be known : and secondly, where LT bears but a small Proportion to TS ; as is the Case with respect to the Distance of the Moon from the Earth, and the Earth from the Sun ; I say, in this case the Force, as r M or LM, at the Quadratures, will be to the Force MT or T *t*, at the Conjunction or Opposition, nearly and without any sensible error, as 1 to 3 : and therefore, if the Proportion LT to TS be given, the Proportion of the same LT to any other Quantity, whose Ratio to TS is given, may be easily found.

COROLLARY I.

FROM this general Construction it follows, that by the Attraction and Perturbation of the Sun at S, the Motion of the Body L about the Centre T, will be accelerated from the Quadratures to the next Conjunction or Opposition ; and as much retarded from the Syzygys to the Quadratures.

FOR while the Body moves from A to B, in the same Fig. 6. the perturbing Force

MT

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MT being directed from M or T towards S, by conspiring with the proper Motion of the Body L in its Orbit, must accelerate it towards B. But from B to C, the same Force MT directed towards S, being contrary to the Motion of the Body in its proper Orbit, must retard it just as much as it had been accelerated before from A to B: but in the Motion from C to D, the central Body T will be more attracted towards S, than the revolving Body L, by the Excess  $Tt$ ; which is evidently the same thing, with respect to the sensible Effect at  $l$ , as if the Body T, retaining its former Position, or not being attracted towards S by any Excess at all, the Body at  $l$  should be attracted the contrary way, from  $l$  to  $q$ , or from T to M; which conspiring with its proper Motion towards D, must accelerate it again; and for the same reason and necessity, in its progressive Motion from D to A, it will be as much retarded: that is, it will be accelerated from the Quadratures to the Syzygia, and retarded from the Syzygia to the Quadratures, by the Excess or Defect of the perturbing Force, which is expounded or represented by MT or  $Tt$ .

COROLLARY II.

FROM hence 'tis plain, that in the same case as before, the greatest Perturbations of Motion are in the Syzygys and Quadratures. For in the Quadratures A and C, the Forces  
MT

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MT and  $Tt$  vanish; and the Tendency of the Body L to the Centre T, is augmented by the whole Force  $rM$ . But in the Syzygia B and D, the Gravity towards T is still increased by the Force which is as  $LT$ , but diminished by the Force  $MT = 3LT$ : but  $3LT - LT = 2LT$ ; and consequently the Diminution of Gravity in the Syzygia is twice as great as its Augmentation in the Quadratures.

COROLLARY III.

HENCE also as these perturbing Forces,  $rM$  and  $MT$ , either accelerate or retard the Motion of the Moon in her elliptick Orbit about the Earth, the Eccentricity of her Orbit will be perpetually changing, and increased or diminished by turns, so as sometimes to amount to 66782 of such Parts, as her mean Distance contains 1000000; and at other times not to exceed 43319 such Parts. And as this is certain in fact from astronomical Observation, so it exactly agrees by Calculation with these perturbing Forces, arising from the Sun's Attraction, as the adequate Effect of such a Cause.

COROLLARY IV.

HENCE if the Distance  $LT$  be call'd  $r$ ,  $TS$ ,  $R$ , the periodical Time of L about T,  $p$ , and the periodical Time of L and T about S,  $P$ ; the perturbing Force  $rM$  will be to the Force by which the Body L is retain'd

E in

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in its Orbit about T, as  $\frac{p^2}{p^2}$ : for the Ratio of the perturbing Force  $rM$  or  $LT$ , to the Force by which the Body L is retain'd in its Orbit about L, is compounded of the Ratio of  $LT$  to  $TS$ , and of  $TS$  to the Force by which L revolves about T: but  $TS$  expounds the Force by which T revolves about S, by the Construction; and this Force is as  $\frac{R}{p^2}$  to  $\frac{r}{p^2}$ , *Prop.* 8. that is, as the Distances directly, and the Squares of the periodical Times reciprocally. Therefore the perturbing Force, as  $LT$  or  $r$ , is to the Force by which the Body L revolves about S, in the Ratio compounded of  $\frac{r}{R}$  and  $\frac{Rp^2}{r p^2}$ ; that is,  $\frac{rRp^2}{Rrp}$ , or as  $\frac{p^2}{p^2}$ .

COROLLARY V.

THE Distance  $LT$ , and the periodical Time of L about T, remaining the same, the perturbing Force  $rM$  or  $LT$ , will be as the Cube of  $TS$  reciprocally: for this Force being as  $\frac{p^2}{p^2}$  by the last Corollary; if  $p^2$  be a standing Quantity, the same Force will be as  $\frac{1}{p^2}$ : that is, as  $\frac{1}{R^3}$ , by *Prop.* 9. For since by that Proposition, the Squares of the periodical Times are ever as the Cubes of the Distances; therefore the Ratio  $\frac{1}{p^2}$  will be equivalent to

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$\frac{1}{R^3}$ : that is, the periodical Time of the perturbed Body, and its Distance from the Centre of its Motion remaining the same, the perturbing Force, as  $rM$  or  $LT$ , will be as the Cubes of the Distances of the perturbing Body or Bodys reciprocally. And universally, since these Forces are  $\frac{p^2}{p^2}$ , and since  $p^2 : P^2 :: r^3 : R^3$ ; therefore,  $\frac{p^2}{P^2} = \frac{r^3}{R^3}$ . And consequently, if  $p$  and  $r$  be considered as standing Quantitys, the perturbing Forces will be as  $\frac{1}{p^2}$ , or  $\frac{1}{R^3}$ : but if  $P$  and  $R$  be considered as standing Quantitys, the perturbing Forces will be as  $\frac{p^2}{1}$ , or as  $\frac{r^3}{1}$ : from whence the Ratio of the Distances or periodical Times being given, the Ratio of the perturbing Forces will be found.

### COROLLARY VI.

HENCE likewise these perturbing Forces are ever as the Cubes of the apparent Diameters of the perturbing Bodys, multiply'd into their Densitys. For 'tis evident, that at equal Distances, the perturbing Forces must be as the Quantitys of Matter in the perturbing Bodys; that is, as the Cubes of their Diameters multiply'd into their Densitys. But in this case, the apparent Diameters are as the real Diameters; and therefore the perturba-

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ting Forces will be as the Cubes of the apparent Diameters multiply'd into the Densities. And because the Cubes of the apparent Diameters are inverſly as the Cubes of the Diſtances; and the perturbing Forces increaſe or decreaſe in the ſame inverſe triplicate Ratio of the Diſtances, by what has been already demonſtrated; therefore, at all Diſtances, theſe perturbing Forces will be as the Cubes of the apparent Diameters of the perturbing Bodys multiply'd into their Densities.

S C H O L I U M II.

UPON the ſame Principles, and by a like Method of reaſoning, *mutatis mutandis*, the Phænomena of the Tides may be explain'd and accounted for. To which purpoſe, *Fig. 6.* let ABCD represent the Earth, ſuppoſed to be covered with Water; T the Centre, L a ſmall portion or particle of Water upon the Surface, and S the Sun, or ſome diſtant Body, to which the Waters gravitate, or by which they are attracted in the inverſe duplicate Ratio of the Diſtances. Then if TS expounds the Attraction of the Fluid at T towards S, S will expound the Attraction at L, and  $nS$  the Attraction at  $l$ ; which will be reſolved into two Forces, as MS and  $rM$ , and  $tS$  and  $nt$ . And conſequently  $rM$ , MT and  $tT$ ,  $nt$ , will represent the Exceſs and Difference of the Attractions at L and  $l$ , above and below the mean Attraction TS; which will be therefore proportional to the per-

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perturbating Forces. 'Tis manifest that the weight or tendency of the Fluid at L towards the Centre T, will be lessened by the Force as MT, and increased by the Force as LT: And therefore, when by the Convolution of the Earth about its Axis, the Point L comes to B; since MT or  $tT$  in this, will be equal to  $3LT$ ; the Gravity at B and D will be lessened by a Force, as  $3LT - LT$ , or  $2LT$ , and increased at A and C by the Force as LT: which is the same thing in effect, as if the Force as LT, did not act at all at the Quadratures A and C; but the Gravities in the Syzygys B and D, were lessened by the whole Force MT, or  $Tt = 3LT$ . Now from this diminution of Gravity, 'tis evident that the Fluid must recede from A towards B, and from C towards D, and ascend at the Points B and D, to keep up its Æquilibrium: by which means, the Sphere ABCD will be reduced to an oblong Spheroid, whose greater Diameter DB continued, will pass thro' the Centre of the Sun at S. And from hence, by the Revolution of the Earth about its Axis, the Waters will flow and reflow, to and from the Points B and D alternately; and there will be two Tides and two Ebbs in 24 Hours.

THE same thing will happen by the Attraction of the Moon; only the Attraction of the Moon being much stronger than that of the Sun, the Effect will be proportional. But it must here be observed, that from these

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two Causes, there will not be form'd two distinct Tides : for the stronger Attraction must prevail in the sensible Effect, and produce one compound Tide ; which will be as the Aggregate or Difference of the two Forces, as they happen to conspire with, or to oppose each other.

PROPOSITION XXIII.

*IF a Corpuscle be placed within a concave Sphere, whose Surface consists of Parts attracting each other mutually, in the reciprocal duplicate Ratio of their Distances ; the said Corpuscle thus placed any where within the Concavity, will not be attracted at all, but every where remain in a state of Rest or Æquilibrio.*

LET *abcd* be the Surface of such a Sphere, and *p* a Corpuscle placed any where *ad libitum*, within its Concavity, Fig. 7. By *p* draw the Lines *ad*, *bc*, intercepting the small Surfaces *ab*, *cd* : the Figures *apb* and *cpd* being similar, the Arches *ab*, *cd*, will be proportional to the Radii *ap*, *pd*, or *bp*, *pc* ; and the spherical Surfaces *ab*, *cd*, will be in the duplicate Ratio of those Radii respectively. Therefore the Attraction of the Corpuscle *p* to the spherical Surfaces *ab* and *cd* will be equal. For with regard to the Quantity of Matter in the spherical Surface *cd*, the Corpuscle *p* must be more attracted to the said Surface *cd*, than to the

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Surface  $ab$ , in the duplicate Ratio of  $cp$  to  $bp$ ; and with regard to the greater Distance  $cp$ , the said Corpuscle will be less attracted to the same Surface  $cd$ , than to the Surface  $ab$ ; and that in the same duplicate Ratio of  $cp$  to  $bp$ , which must therefore constitute a Ratio of Equality: and consequently those equal Attractions in contrary Directions, must mutually destroy each other. And by the like method of reasoning, all the Attractions thro'out the whole Concavity of the Sphere, will be destroy'd by equal Attractions in contrary Directions; and the Corpuscle  $p$ , any where posited within the said Concavity, will remain in a state of Rest or *Æquilibrium*: *Which was to be demonstrated.*

COROLLARY I.

HENCE in a solid Sphere, whose constituent Parts attract each other mutually, in the reciprocal duplicate Ratio of their Distances, the Attractions of equal Corpuscles within the Surface to the Centre of the Sphere, will be in the simple direct Ratio of their Distances from the Centre. For by the last Proposition, a Corpuscle at  $a$ , *Fig. 8.* is not at all attracted to the Surface  $ABCD$ ; that Attraction being every where destroy'd by equal Attractions in contrary Directions: and therefore the Attraction of the Corpuscle  $a$  to the Centre  $R$ , will be the same as if it lay upon the Surface of a Sphere of the same Density, whose Radius should be equal to  $Ra$ ; that is,

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the Densities being equal, as is here supposed, the Attractions of the Corpuscles *A* and *a* to the Centre *R*, will be as the Spheres *ABCD* and *abcd* directly, and the Squares of the Distances *RA* and *Ra*, reciprocally: namely, as  $RA^3 \times Ra^2$  to  $Ra^3 \times RA^2$ ; or as *RA* to *Ra*. Therefore if a solid Sphere consists of Parts, which attract each other as the Squares of the Distances reciprocally, Corpuscles placed within the Surface of any such Sphere, will be attracted to the Centre in the simple direct Ratio of their Distances from the same Centre: *Which was to be demonstrated.*

C O R O L L A R Y II.

IF a Cavity be conceived to be made quite thro' the Earth, according to the Direction of its Diameter; from whatever Altitude a Body be supposed to be let fall in the said Cavity towards the Centre, it will come to the Centre in the same given Time; and being arrived to the Centre, it will ascend to the same Altitude on the other Side, and then return to the Point from which it was let fall; and so continue this Reciprocation of Ascent and Descent, after the manner of a vibrating Pendulum. For since in all moving Bodys, the Times are ever as the Spaces to be described directly, and the Velocitys reciprocally; that is, as the Spaces divided by the Velocitys: 'tis manifest, that where the Velocitys increase or decrease in proportion to the

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the Spaces to be describ'd, all Spaces, by Bodys moving according to this Law, will be describ'd or pass'd thro' in the same or equal Time. But in this case of the perpendicular descent of Bodys within the Surface towards the Centre of the Earth, the Velocitys are the accelerating Gravitys towards the Centre, which are as the Distances from the Centre, by the Proposition; which Distances from the Centre are the Spaces to be describ'd, by the Supposition: And therefore both these must constitute a Ratio of Equality; and the Descent of Bodys thro' all Altitudes from within the Earth's Surface towards the Centre will be perform'd in the same or equal Times. Now whatever Velocity a Body acquires, in falling from any given Altitude within the Surface to the Centre of the Earth, will oblige it to ascend to the same Altitude on the other Side; where the Force acquired in its Fall being destroy'd, it will return by the Attraction of the Centre, and ascend again by the same Force to the same Altitude from which it was let fall. And thus abstracting from all Resistance, it must for ever continue its reciprocal Ascent and Descent, after the manner of a vibrating Pendulum.

### PROPOSITION XXIV.

*THE Time in which a Body let fall from any given Altitude within the Surface, would come to the Centre of the Earth, and ascend again to the same Altitude on the other Side; that*

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that is, the whole Time of such an Oscillation, as supposed in the foregoing Corollary, is equal to the semi-periodical Time of a Body revolving about the Earth, at the Distance of one Semidiameter, and retain'd in its Orbit by the sole Force of Gravity, such as it obtains at the Earth's Surface.

FIG. 9. Let a Body revolve in the Circle  $A p E Q$ , at the Distance  $A r$ , equal to the Semidiameter of the Earth; and let it be kept revolving by a Force equal to that of Gravity, as it obtains at the Earth's Surface: Then the central Force, and the transverse Diameter, remaining the same, the Body, by what has been already demonstrated, will describe the Semi-ellipses  $A a E$  or  $A q E$ , in the same Time with the semicircular Arch  $A p E$ . Let now the conjugate Diameter be lessened in *infinitum*, and the Eccentricity increased, till the Foci come to coincide with the Extremitys of the transverse Diameter, or with the Points  $A$  and  $E$ ; then will the Ellipses  $A a E$  or  $A q E$  degenerate into, or coincide with the right Line  $A E$ ; and the Body will describe the Line  $A E$ : that is, it will fall from  $A$  to the Centre  $r$ , and ascend to  $E$ , in the same Time that it would describe the Semi-ellipses  $A a E$ ,  $A q E$ ; or the semicircular Arch  $A p E$ .

PROPOSITION XXV.

*THE Time in which a Pendulum of any given Length will perform its Vibration, is equal to the semi-periodical Time of a Body revolving by the Force of Gravity in an Orbit, whose Radius or Semidiameter is equal to the Length of the Pendulum.*

FOR since in Fig. 9. from whatever Point between A and  $r$  a Body be let fall, it will come to the Point  $r$ , and ascend again to the same Height on the other Side, in a given Time; namely, in the semi-periodical Time of its Revolution about the Centre  $r$ , by the sole force of its own Gravity; and since a pendulous Body moving in a Cycloid, vibrates all Arches in the same Time, and moves by the sole Force of its own Gravity; 'tis evident that the Law of Motion must be the same in both Cases.

SCHOLIUM.

THIS Proposition must be understood only of pendulous Bodys moving in Cycloids: for where a Pendulum moves in a circular Arch, it will take up somewhat a longer Time in vibrating a greater than a smaller Arch. The Time of Vibration therefore here limited, with respect to a circular Arch, will hold good but in the smallest or very minute Arches, and where the very small Portion of the Circle may be supposed to coincide with the Cycloid.

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cloid. Now this being supposed, the Length of the Pendulum from the Time of its Vibration given, or on the contrary, the Time of Vibration from the Length of the Pendulum, are easily determin'd. For putting  $e$  for the Ratio between the Perimeter and the Diameter of a Circle  $= \frac{3\frac{1}{2}}{1\frac{1}{3}}$ ;  $r$  for the Radius or Length of the Pendulum;  $c$  for the accelerating Force of Gravity in one Second  $= 16,1$  Feet; and  $p$  for the periodical Time; it will be  $\frac{2re^2}{c} = p^2$ , by *Prop. 8.*

Now putting  $t$  for the Time of a Vibration, which is the semi-periodical Time of an entire Revolution; it will be  $t^2 = \frac{1}{4} p^2$ ; and consequently  $\frac{re^2}{2c} = t^2$ : and therefore  $\frac{2ct^2}{e^2} = r$ .

From whence 'tis plain, that the Lengths of Pendulums are as the Squares of the Times of Vibration, and the Times as the Square Roots of the Lengths. And for ready Practice, since the Length of a Pendulum beating Seconds, with us is 39,2 Inches; therefore putting a Second for Unity, the Square of the Time of Vibration, multiply'd by 39,2, gives the Length of the Pendulum in Inches; and the Length divided by 39,2, gives the Square of the Time.

## PROPOSITION XXVI.

*THE Space thro' which a heavy Body will descend perpendicularly, during the Time that a given Pendulum performs its Vibration, is to half*

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*half the Length of the Pendulum, in the duplicate Ratio of the Circumference to the Diameter.*

THE Space thro' which a Body will descend perpendicularly in a given Time, is equal to the Square of the Arch described in the same Time, divided by the Diameter. But in this case, the Time of a Vibration is the semi-periodical Time of an intire Revolution; or the Time in which the Body revolving by the same Force of Gravity, would describe the Semi-circumference, by the *last Proposition*. And therefore, retaining the same Symbols as before,  $r^2 e^2$ , the Square of the Semi-circumference, divided by  $2r$  the Diameter, gives  $\frac{1}{2} r e^2$ : But  $\frac{1}{2} r e^2$ , the Space described in the perpendicular Descent, during the Time of one Vibration, is to  $\frac{1}{2} r$ , half the Length of the Pendulum, as  $e^2$  to 1; that is, as the Square of the Circumference to the Square of the Diameter.

### COROLLARY I.

HENCE the Time in which a Pendulum performs its Oscillation, is to the Time of perpendicular Descent thro' half the Length of the Pendulum, in the Ratio of the Periphery to the Diameter. For those Spaces being described by an accelerated Motion, and being in the duplicate Ratio of the Circumference to the Diameter, by the *Proposition*; the Times, which are as the Square Roots of the

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the Spaces, must be in the simple Ratio of the  
Circumference to the Diameter.

COROLLARY II.

HENCE 'tis likewise evident, that the Length of a Pendulum vibrating in a given Time, is ever proportional to the accelerating Gravity; *i. e.* to the Space described by the perpendicular Descent of a Body in the same Time: but the Length of the Pendulum being the same, the Gravities are as the Squares of the Times of Oscillation inversely; and consequently, where by the nearer approach to, or farther recess from the Centre of Attraction, the Gravity is increased or diminished, this augmentation or diminution of Gravity may be easily determined.

PROPOSITION XXVII.

*IF a large Sphere or Globe, such as the Earth, be made to revolve about its Axis while it is in a state of Fluidity, it will by such a Motion acquire the Form of an oblate Spheroid; in which the Proportion of its Axis to its equatorial Diameter, will be as the Length of a Pendulum vibrating Seconds at the Equator, to the Length of a Pendulum vibrating in the same Time at the Poles.*

IF a fluid homogeneous Sphere consisting of Parts of an equal and uniform Density, be turned about an Axis, 'tis plain that the Gravitation of the Parts towards the Centre will  
be

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be hereby lessen'd or diminish'd, in proportion to the centrifugal Force generated by such a circular Motion. And because the centrifugal Force increases from the Poles to the *Æquator*, where it is greatest of all; therefore the Fluid must recede from the Poles, and rise towards the *Æquator*, in order to retain its *Æquilibrium*; that the Length of the Canals may compensate for the Diminution of Gravity: by which means the Sphere will be reduced to an oblate Spheroid. Now let *AaEP*, *Fig. 9.* represent the Earth revolving about its Axis *Pa*; *AE* the *Æquator*, and the Points *P* and *a* the Poles: Let this Spheroid be supposed to consist of small cylindrical Canals of equal Bases, communicating at the Centre; and 'tis plain, the absolute Weights of the Canals *Ar*, *Pr*, &c. must be respectively equal: for in that case only can the Centre be equally press'd, and the Fluid retain'd in *Æquilibrio*. But these Weights are as the Quantities of Matter multiply'd into the accelerating Gravities; that is, in this case, as the Lengths of the Canals, multiply'd into the accelerating Gravities. And consequently the accelerating Gravities are reciprocally as the Lengths of the Canals: and therefore the accelerating Gravity at *A*, is to the accelerating Gravity at *P*, as *Pr* to *Ar*. But the accelerating Gravities have a constant given Ratio to the Lengths of a Pendulum vibrating in the same Time, by the last Proposition; and therefore the Canals will be likewise

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wise reciprocally as these Lengths: that is, the Length of a Pendulum vibrating Seconds at A, will be to the Length of a Pendulum vibrating Seconds at P, as  $P r$  to  $A r$ : Which was to be demonstrated.

## PROPOSITION XXVIII.

*SUPPOSING the same as in the last Proposition; the Augmentations of Gravity, in going from the Æquator to the Poles, will be in the duplicate Ratio of the Sines of the Latitude.*

LET  $APEp$ , Fig. 10. represent the Earth,  $AE$  the æquatorial Diameter,  $Pp$  the polar Diameter or Axis; and let  $D$  represent a Body suspended by the Thread  $BD$ , and placed any where between the Æquator  $A$ , and the Pole  $P$ ; and draw  $DS$  perpendicular to the Axis  $Pp$ . 'Tis plain, if the Earth had no diurnal Rotation, the Body  $D$  would draw the Thread  $BD$  into the Position  $BC$ , where it would stretch the Thread with the whole Force of its Gravity, by endeavouring to descend directly to the Centre  $r$ : or if we suppose the centrifugal Force to act according to the same Direction  $rC$ , it would then directly oppose the Force of Gravity, and the Thread would remain in the same Position, only it would be stretch'd but with the Difference of these two Forces. But because the Body  $D$  turns round the Centre  $S$ , it will endeavour to recede from the said Centre in the Direction

$CD$ ;

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CD; by which means, the Thread will be drawn into the Position BD. Let  $Dn$  be drawn perpendicular to  $BC$ ; then if  $DC$  represent the centrifugal Force acting in the Direction  $SD$ , it is equivalent, by *Prop. 3.* to two Forces; one of which is as  $Cn$ , and acts according to the Direction  $Cn$ , which is contrary to the Force of Gravity towards  $r$ ; the other as  $nD$ , and acts in the Direction  $nD$ , which is no way contrary to the Force of Gravity. If therefore  $CD$  represent the whole centrifugal Force at  $C$ ,  $Cn$  will represent that part of it which is contrary to the Force of Gravity. Draw  $Dm$  parallel to the Axis  $Pp$ ; then will the Triangles  $CSr$ ,  $CDm$ , and  $CDn$  be similar: and therefore it will be,  $Ar$  or  $Cr:CS::Cm:CD::CD:Cn$ ; and,  $Cr:rS::Cm:Dm$ . Consequently, if  $CD$  represents the whole centripetal Force at  $C$ , and  $Cn$  that part of it which is contrary to the Force of Gravity,  $Cm$  will expound the centripetal Force at the *Æquator*, and  $mn$  the Augmentation or Excess of Gravity at  $C$ , above the Gravity at  $A$ . But  $mC$  is to  $mn$  in the duplicate Ratio of  $mC$  to  $mD$ , or of  $Cr$  to  $rS$ ; that is, the centripetal Force, or decrease of Gravity at the *Æquator*, is to the increase of Gravity, or diminution of the centripetal Force at  $C$ , as the Square of the Radius to the Square of the Line of the Latitude: and consequently the Augmentations of Gravity from the *Æquator* to the Poles,

F are

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are in the duplicate Ratio of the Sines of the  
Latitude.

PROPOSITION XXIX.

*THE Earth by the Rotation about its Axis,*  
*is reduced to an oblate Spheroid, whose Axis, or*  
*polar Diameter, is to the Diameter of the Æ-*  
*quator nearly as 124 to 125.*

THE Length of a Pendulum which vi-  
brates Seconds at *Paris*, is 36 *Paris* Inches,  
and  $8\frac{1}{2}$  Lines, or  $440\frac{1}{2}$  Lines; and by com-  
paring together of many repeated Observa-  
tions, with proper Allowances for the greater  
Heat and Rarefaction under the Æquator, it  
has been found, that a Pendulum beating  
Seconds at the Æquator, must be 2 Lines  
shorter than a Pendulum vibrating in the  
same Time at *Paris*: and consequently, a  
Pendulum whose Length is  $438\frac{1}{2}$  Lines, will  
vibrate Seconds at the Æquator. Now the  
Latitude of *Paris* is  $48^{\circ} 50'$ : and since the  
Augmentations of Gravity are as the Squares  
of the Lines of the Latitudes, by the last  
*Proposition*; and the Gravities are as the  
Lengths of the Pendulums, by *Prop. 27.*  
therefore, as the Square of the Line of the  
Latitude of *Paris*, or the Square of the Line  
of  $48^{\circ} 50'$ , is to the Square of the Radius,  
so is the Augmentation at *Paris*, 2 Lines, to  
the Augmentation at the Poles; which will  
be found to be 3,529 Lines; which being  
added to 438,555, the Length at the Æqua-  
tor,

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tor, gives 442,084, the Length of a Pendulum beating Seconds at the Poles: but the Distances from the Centre are reciprocally as these Lengths; and therefore the Semiaxis of the Earth will be to its Semidiameter at the Æquator, as 438,555 to 442,084; that is, nearly as 124 to 125: *Which was to be demonstrated.*

PROPOSITION XXX.

*TO find the perturbing Forces of the Sun and Moon, upon the Ocean and Atmosphere.*

ACCORDING to the best and most accurate Observations, the mean Semidiameter of the Earth is 21034840 *English Feet*: and since the Ratio of the Earth's Axis to its æquatorial Diameter, is as 124 to 125, by the last *Proposition*; therefore, the Semiaxis will be 20950363, and the æquatorial Semidiameter 21119317 *English Feet*; and their Difference 168954 Feet: which is the Elevation of the Æquator above the Poles, arising from the Rotation of the Earth about its Axis. And since by *Prop. 22.* and its *Corollarys*, the perturbing Forces are inversely as the Squares of the periodical Times; therefore the centrifugal Force of the Æquator will be to the perturbing Force of the Sun, which is as  $Mr$  or  $TL$ , *Fig. 6.* as the Square of the Earth's periodical Time about the Sun, to the Square of the Earth's periodical

F 2

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dical Time about its Axis ; that is, as the Square of  $366\frac{1}{4}$  to 1 ; or as 134139 to 1.

BUT the Force  $rM$ , is  $\frac{1}{3}$  of the whole conjunct Forces  $rM$  and  $MT$ , by which the Fluid is depress'd at the Points A and C, and elevated at B and D ; and consequently the whole perturbing Force of the Sun, by which the Fluid is elevated in the vertical Points, or in the Sun's Zenith and Nadir, and depress'd in the Horizon of these Points, will be  $\frac{1}{3} \times \frac{1}{4} = \frac{1}{12}$  or  $\frac{1}{44713}$  of the centrifugal Force at the Æquator : And since the centrifugal Force at the Æquator raises the æquatorial Parts above the polar 168954 Feet, as before shewn ; therefore the perturbing Force arising from the Attraction of the Sun, will raise the Fluid in the Sun's vertical Points above the Horizon of those Points  $3\frac{7}{9}$  Feet : For,  $44713 : 168954 :: 1 : 3\frac{7}{9}$ . And because by Observations made on the different Height of the Tides, at the New or Full Moons and Quadratures, the Force of the Moon, in this case, is to that of the Sun as 9 to 2 ; therefore where the Sun by its single and sole Attraction raises the Waters  $3\frac{7}{9}$  Feet, the Moon will elevate the same Fluid 17 Feet : For,  $2 : 9 :: 3\frac{7}{9} : 17$ . And since the single Force of the Sun produces an Elevation  $3\frac{7}{9}$  Feet, and that of the Moon an Elevation of 17 Feet, the Sum of their Forces, by which the Tides are raised at the New and Full Moons, will be  $20\frac{7}{9}$  ; and their Difference at the Quadratures  $13\frac{2}{9}$  Feet.

BUT

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BUT these perturbing Forces of the Sun and Moon are subject to several Variations, some of which must be here brought into the Account, as being very sensible and considerable in their Effects. And,

I. WHAT has been hitherto said, must be understood of the Sun's and Moon's Forces at their mean Distances from the Earth; but at other Distances, by what has been already demonstrated, these Forces and their proportional Effects will be reciprocally as the Cubes of those Distances, or directly as the Cubes of the apparent Diameters. And since the Eccentricity of the Earth in its annual Orbit about the Sun, is  $\frac{1}{87}$  of the middle Distance, nearly; if the middle Distance be taken as 60, the greatest Distance will be as 61, and the least as 59: and therefore, at the greatest Distance, the Elevation from the Attraction of the Sun will be  $3\frac{1}{2}$ ; and at the least Distance, the Elevation will be four Feet, *ferè*.

THE greatest Eccentricity of the Moon in her Orbit is 6678 of such Parts, as the mean Distance contains 100000; and consequently, the Moon's greatest Distance from the Earth will be 106678, and the nearest 93322 such Parts. And since the perturbing Forces and their Effects are inversely as the Cubes of these Distances, it will follow, that if the Attraction of the Moon at the Distance 100000, raises the Tides 17 Feet at the Distance 106678, the Elevation will be 14; and at the

F 3                      Distance

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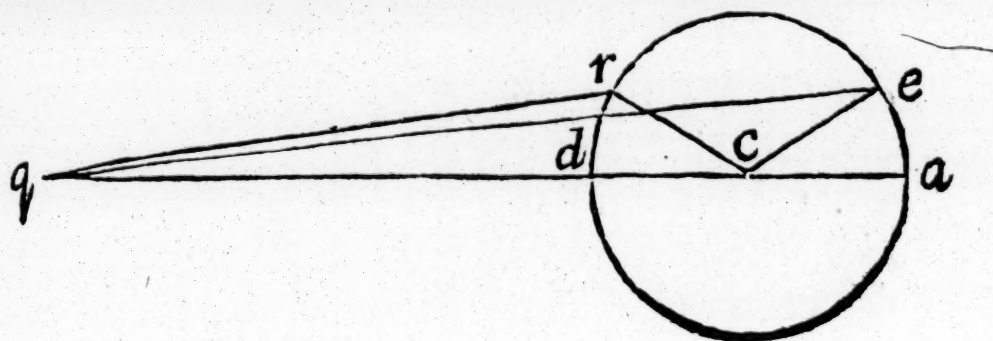
Distance 93322, the Waters will rise to 21 Feet, nearly. But then,

2. WHAT has been here observed, supposes the Sun and Moon, or the Body by whose Attraction the Tides are raised, to be in the vertical Points, or in the Zenith or Nadir, where such Elevations are produced. But in case the perturbing Body be at any Distance from the vertical Points, or less than 90 Gr. above or below the Horizon, these perturbing Forces and their Effects, will be lessen'd in the duplicate Ratio of the Sines of the Altitudes to the Radius. Now the Latitude of a Place being given, its Complement to 90 Gr. is the Altitude of the *Æquator* where it intersects the Meridian; then any North Declination of the Sun or Moon added to, or South Declination subtracted from this Altitude of the *Æquator*, the Sum or Difference will be the Meridian Altitude of the Sun or Moon respectively: which being obtain'd, as the Square of the Radius is to the Square of the Meridian Altitude, so is the vertical Elevation  $3\frac{7}{8}$  for the Sun, or 17 Feet for the Moon, to the Elevation or Height of the Waters at the Place given.

3. THERE is another Difference of these perturbing Forces and their Effects, arising from the various Positions of the Sun and Moon with respect to each other, between the Conjunctions, or Oppositions, and the Quadratures.

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dratures. At the Conjunctions and Oppositions they act, as has been observ'd, with the Sum; but at the Quadratures, with the Difference of their Forces. But between these, those Forces are variously combin'd; and in this case the compound Force, whether additional or differential, may be thus determined:



IN the Figure annex'd, let  $qc$  represent the perturbing Force of the Moon, or the Elevation of the Tides from the sole Attraction of the Moon, and let  $ca$  expound the like Force of the Sun. Upon the centre  $c$ , with the Radius  $ca$ , describe the Circle  $aeda$ ; then will  $qa$  represent the Sum of the Forces of the Sun and Moon, and  $qd$  the Difference of their Forces: make the Angles  $ace$  or  $dcr$ , equal to twice the Moon's Distance from the next Conjunction or Opposition; then will the Lines  $qe$  or  $qr$ , represent the compound Force or Elevation of the Waters at the Points  $e$  and  $r$  respectively. But in the Triangles  $qec$  or  $qrc$ , the Sides  $qc$  and  $ec$ , or  $qc$  and  $rc$ , being given, with the Angles included, either of the other Angles, and

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consequently the Sides  $qe$  or  $qr$ , will be easily found from the known Rules of *Plain Trigonometry*.

C O R O L L A R Y.

FROM hence it will be manifest, that these perturbing Forces bear so small a Proportion to the Force of Gravity, that they cannot at all alter the Weight of Bodys with us, or be discover'd by the Rise and Fall of the Mercury in the Barometer, nor by any other hydrostatical Experiments whatever. For by what has been demonstrated in the *Proposition*, the perturbing Force of the Sun is to the centrifugal Force at the *Æquator*, as 1 to 44713; and the centrifugal Force at the *Æquator* is to the Force of Gravity with us, (by which Bodys descend 16,1 Feet in one Second) as the Square of the periodical Time at the Earth's Surface, to the Square of the periodical Time of the Earth about its Axis; that is, as the Square of  $84\frac{2}{3}$  to the Square of  $1436\frac{1}{3}$  Minutes, or as 1 to 287,69; and consequently the perturbing Force of the Sun is to the Force of Gravity in a Ratio compounded of 1 to 44713, and of 1 to 287,69; which is the Ratio of 1 to 12863470. It will farther appear by a Computation from the foregoing Principles, that the conjunct Forces of the Sun and Moon in their greatest Quantity, is to this mean perturbing Force of the Sun, as 33 to 5; and consequently this greatest compound Force, will be to the Force

## *general Laws of Gravity.* 73

Force of Gravity with us, as 1 to 1949000 ; which cannot raise or sink the Mercury in the Barometer above  $\frac{1}{8000}$  of an Inch. And therefore, if those who have made a serious Question of it, Why these perturbing Forces are not discover'd by the different Heights of the Mercury, at the New or Full Moons and Quadratures ; and who have gone about to assign very remote and obscure Reasons for it, had but first reduc'd this Matter to a *Calculus*, they might have sav'd all their other Pains ; since they would have found that the Cause they were considering, could not possibly have any such sensible Effect as they expected from it.

### PROPOSITION XXXI.

*ALL the physical sensible Effects that can proceed from such a Cause of Attraction and Perturbation of Motion in our Ocean and Atmosphere, must be owing to the Sun and Moon ; and all the other Planets and Fix'd Stars are wholly to be rejected, and left out of the Account in the present Case.*

FROM what has been already demonstrated, 'tis evident, that the Sun and Moon must have very sensible and considerable Effects upon our Ocean and Atmosphere ; and by a Computation from the same Principles, it will appear, that the other Planets and Fix'd Stars can have no such Effects at all, that can come into any physical Account. For since  
by

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by what has been shewn at *Prop. 22.* these perturbing Forces are ever as the Densities of the perturbing Bodys, multiply'd into the Cubes of their apparent Diameters; therefore, where the Densities and apparent Diameters are given, the Ratio of the perturbing Forces will be likewise given. Now the apparent Diameter of the Sun at a mean Distance is  $32' 15''$ , or  $1935''$ ; and the Sun's Density 100; *Saturn's* apparent Diameter, when nearest to us, is  $22''$ ; and *Jupiter's*  $52''$ ; *Saturn's* Density 32, and *Jupiter's* 73. And therefore the Perturbation of the Sun will be to that of *Saturn*, as the Cube of  $1935 \times 100$ , to the Cube of  $22 \times 32$ , or as 2175834 to 1: and consequently, where the Sun at a mean Distance raises the Tides  $3\frac{1}{2}$  Feet, *Saturn* with his greatest possible Force will raise the Waters only  $\frac{1}{48280}$  of an Inch. And by the same Method of reasoning, the perturbing Force of the Sun will be to that of *Jupiter*, as 70585 to 1; and *Jupiter's* Attraction, when greatest, will not raise the Waters of the Ocean more than  $\frac{1}{1557}$  of an Inch. But the Planet which seems to bid fairest for any real physical Effect upon our Ocean and Atmosphere, is *Venus*; whose Density, for want of a Satellite, cannot be exactly determin'd. But I shall suppose, that the same Ratio of the Densities obtain'd here, as with respect to the *Sun*, the *Earth*, *Saturn* and *Jupiter*; that is, that the Density is reciprocally as the Distances: then will the

Density

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Density of *Venus* be 550, her apparent Diameter, when nearest the Earth, is 80''; and then the Force of the Sun will be to that of *Venus*, as 2573 to 1; and *Venus* will only raise the Tide  $\frac{1}{8}$  of an Inch: and the perturbing Force of *Mars* and *Mercury* will still be less. Farther, I shall suppose the Fix'd Stars to be of the same Density with the Sun, since they are manifestly Bodys of the same Nature and Kind: then will their perturbing Forces be as the Cubes of their apparent Diameters. Now a Fix'd Star has no sensible Diameter, even when view'd thro' a Telescope, which magnifys the Diameter 200 times; and consequently the apparent Diameter of a Fix'd Star must be less than  $\frac{1}{200}$  of a Minute, and will be to the apparent Diameter of the Sun, in a Proportion less than that of 1 to 6400: the perturbing Force of the Sun therefore will be to that of a Fix'd Star, in a Ratio greater than 2600000000000 to 1. From whence it must follow, that if twenty six thousand of these Fix'd Stars were to be amass'd in one, or to act in the same Direction, their attractive Forces would not be sufficient to raise the Waters of our Ocean the thousandth Part of an Hair's breadth. Now 'tis plain that these attractive perturbing Forces of the Planets and Fix'd Stars, are physically evanescent, and of no moment at all; and consequently, all physical sensible Effects of this kind must be attributed to the Sun and Moon.

P R O-

## PROPOSITION XXXII.

*WHAT has been hitherto demonstrated, concerning the perturbing Forces of the Sun and Moon upon the Ocean, in producing the alternate Flux and Reflux of the Waters, must be consequently understood also of the Atmosphere, in which the same Perturbations of Motion must likewise happen.*

THIS is evident from the Nature of the Atmosphere, or Body of Air, which every way furrounds the Earth, to the Height of about fifty geographical Miles; and which being a Fluid must necessarily be subject to the common Laws of all other Fluids. And consequently, wherever its Gravity is lessened, the Fluid must flow in from other Parts, and raise the Columns or Heights of the Fluid proportional to the Diminution of Gravity, in order to keep up the *Æquilibrium*.

## PROPOSITION XXXIII.

*THESE Perturbations of the Ocean and Atmosphere must necessarily be impress'd upon the Blood and animal Fluids, and produce very sensible and considerable Effects in animal Bodys.*

To understand and explain which, it must be observed in the first place, that in these alternate Fluxes and Reflexes of the aqueous and ethereal Fluids, as often as the Motion comes to be chang'd, and the Fluids to be  
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impres'd in a contrary Direction ; this must throw the Fluids into a violent Commotion, or intestine mutual Collision and Struggle of the Parts among themselves. Thus in *Fig. 6.* when the Moon or perturbing Body is suppos'd at S, the Fluid will recede from the Points A and C towards B and D, where the Elevation will be greatest ; because the Diminution of Gravity will be there greatest. But when by the Rotation of the Earth about its Axis, the Points D and B come to A and C respectively ; the Fluid, which before receded from A and C towards B and D, must now change its Direction, and flow on the contrary from B and D towards A and C. And hence by the intestine Commotion, Struggle, and mutual Collision of the Parts of the Fluid, the Sea must rage, foam, and fluctuate ; something like what happens in a Vessel fill'd with any Liquor, which having a circular Motion given it one way, when that Direction comes to be changed for a contrary one, the Fluid will by the intestine Commotion and mutual Collision of its Parts, rise, fluctuate, and fly over the Sides of the Vessel. Now by this Agitation and intestine Commotion of the Waters, the smaller and lighter Parts of the Fluid, such as separated from the rest, will be thrown upon the Surface in a sort of Foam or Froth ; where by a farther Agitation from the Heat of the Sun, they will easily rise in Vapour, and fill the Atmosphere with aqueous Particles. The Quantity  
of

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of Vapours therefore rising in a given Time, will be *cæteris paribus*, proportional to these Perturbations of the Waters by the Sun and Moon. And indeed, this thick, foggy, and humid Disposition of the Air, seldom fails of discovering itself to Observation and Sense, even in the driest Seasons.

BUT this intestine Motion and mutual Collision of the Parts of the Fluid, from the Cause just now assign'd, must be still greater in the Atmosphere, on the account of its Elasticity. For the Parts here having no mutual Attraction and Cohesion, but on the contrary a centrifugal Force, any Motion impress'd must have the greater Effects; and the Atmosphere, by the mutual Collision and Struggle of its Parts, will be thrown into the more violent Commotion, and become the more turgid and fluctuating; which must considerably heat and rarefy the fluid elastick *Æther*.

IT must be here observ'd farther, what is very evident in Fact, and confirm'd by numberless Experiments, that the Blood, and all other Fluids, have their Pores and Interstices fill'd with Air: and there being a continual Communication between the Atmosphere or external Air, and the Air included or contain'd in such Fluids, any Constitution, Impression or Determination given to the one, must likewise be communicated to, and equally affect the other. From whence it must follow, that the Atmosphere or external Air,  
being

being put into any violent intestine Commotion, or mutual Collision and Agitation of its Parts, the Air contain'd in the Blood and animal Fluids, must receive the same Impression, and communicate it to that Blood, or to those Fluids themselves.

SCHOLIUM I.

FROM this Account of these perturbing Forces of the Sun and Moon, and how they come to affect the Blood and animal Fluids, any one who is but moderately acquainted with the Laws of Motion, will easily perceive, that such a Cause must have very considerable Effects upon animal Bodys, and such as ought by no means to be neglected, or escape the Notice and Care of a Physician. For,

I. THE whole Atmosphere, and consequently the internal Air contain'd in the Blood, being thus put into a violent intestine Motion, and that Motion being communicated to the Blood, the vital Fluid must in consequence of this be considerably heated and rarefy'd by the expansive Force of its included Air, and its Efforts to unbend and fly off: From which greater Heat and Rarefaction of the Blood, it must necessarily press more strongly upon the Sides of its containing Vessels. And because Fluids press *undiquaque*, the Blood by this lateral additional Pressure will be driven the more forcibly along the  
Axes

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Axes of its containing Vessels, in its projectile Motion from the Heart; that is, the Velocity and *momentum motus* of the Blood will be increased.

2. FROM this greater Heat and Rarefaction of the Blood, arising from its increas'd expansive Force and intestine Motion, there must ensue a greater fullness or plenitude of the Blood-Vessels, while the same Quantity comes to take up a greater or larger Space.

3. BY this greater Heat and Rarefaction of the Blood, the Serum contain'd in it will be more intimately mix'd, and closely cohere with the *Crassamentum*: and the Serum being thus as it were absorb'd and detain'd in the *Crassamentum*, the several Secretions, or the usual Drain of the Serum by the Lymphaticks and glandular Pipes, will be proportionally lessened, and a great Part of the Fluid which us'd to be drawn off by this means, will be detain'd in the Blood-Vessels, and produce a greater Plenitude or Plethora of the Blood-Vessels: and from hence any Hemorrhage or Efflux of the Blood from its proper Vessels, will be augmented and promoted; while all the other natural Discharges by the Glands and Lymphaticks, will for the same Reason and by the same Necessity be lessen'd or diminish'd.

FROM such a Cause as this therefore, 'tis manifest, that all Diseases and Symptoms of  
Diseases,

Diseases, may be generated, increased, or aggravated, which proceed from, or are attended with a too great Plenitude of the Blood-Vessels, and the consequent Defect or Diminution of the Lymph and glandular Secretions. But what these Cases are in particular, and how to be distinctly and successfully apply'd to, must depend upon many other things not yet explain'd; which must therefore be dismiss'd here, and referr'd to their proper Places, in their natural and due Order.

S C H O L I U M II.

THE perturbing Forces of the Sun and Moon, having such Effects upon our Atmosphere and animal Bodys, as I have here observed in general, and shall farther explain hereafter; it might be of some use to Physicians, to enable them the better to judge of and apply to several very great and remarkable Crises of Diseases, if those Forces or their Effects were reduc'd to a *Calculus*; which might be dispos'd of in a Table to be read, to be recurr'd to, and inspected on all Occasions. Such a Table would be a sort of astronomical Barometer or Hydrogage, by which the State and Disposition of the Air, and consequently of the Blood and animal Fluids, might be judg'd of, so far as it depends upon these general Causes; and which I am well assur'd, is in a much greater Degree than is commonly imagin'd. And tho

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the particular and appropriate Causes of Diseases, in the constitutional or accidental State and Disposition of the animal Fluids, are doubtless to be consider'd in the first Place, as limiting, determining, and circumstantiating the more general Causes; yet to neglect a Matter of such Consequence as the Influence and Impression of the Sun and Moon would be found to be upon animal Bodys, is, I think, altogether unbecoming a Physician, as one who is supposed to be devoted to the Study of Nature.

### PROPOSITION XXXIV.

*BESIDES the general Force of Gravity, or the Weight of Bodys, as explain'd and apply'd in the foregoing Propositions, the very small Particles of Matter, which constitute the larger Masses, are endu'd with a strong attractive Force, which exerts itself only at, or extremely near the Points of Contact; and vanishes at any greater Distance: which Force or Power of Attraction, to distinguish it from that of Gravity, may be call'd the Force of COHESION; it being that Force, by which the small Parts of Bodys unite and cohere among themselves.*

THIS appearance or affection of Matter, as respecting the small constituent Parts of Body, is now generally known as evident and undoubted Fact; and is confirm'd upon the most numerous Experiments, made by the  
Royal

## *general Laws of Gravity.* 83

*Royal Society* and others: and therefore I shall only here mention a few unexceptionable Observations and Experiments, by which the Truth of the Proposition must appear in Fact.

'Tis well known, that the small contiguous Parts of Bodys have some Degree more or less of Cohesion, so as to require a certain Force to disunite and separate them: and that this arises from the Attraction of the contiguous Parts, will be evident from the following Appearances of Fluids; where the manner of uniting and cohering may be plainly observ'd.

1. EVERY one knows, that any small Portion of a Fluid separated from a larger Mass, will dispose itself into a little Sphere or Drop; which can only happen from the Attraction of the Particles, of which the Drop consists: The Sphere being the only Figure, in which the mutually attracting Particles can come as near as possible to one another; and in which Form, with respect to any such Power of Attraction, they will remain at rest.

2. LET two small *Spherulae* of Quicksilver be placed upon an horizontal Plane, near to one another; and while they are kept at a small sensible Distance, they will both distinctly rest, without being mutually affected. But as soon as they come at, or extremely near the Point of Contact, they will, by the

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attractive Power of their Parts, run swiftly into one another, and unite in one larger Drop.

3. LET a glass Bubble, or any other Body that will swim, be immers'd in Water, and the Fluid will sensibly rise above the common Surface, and as it were stick or adhere to the Sides of the immersed Body. And the same will happen, if a Sphere of Brass, Iron, or other such Substance be immersed in Quick-silver: which plainly shews, that the Fluid and the immersed Solid mutually attract each other; and that this Attraction, with respect to the contiguous Parts of such Bodys, is superior to the Force of Gravity.

4. Let one End of a small open glass Tube be immersed in Water or any other Fluid, and the Liquor within the Tube will rise to some sensible Height above the external Surface: the Reason of which is plainly this, that some part of the Gravity of the Fluid below, being taken off by the attractive Power of the internal concave Surface of the Glass, the Fluid within the Tube, by the external greater Weight or Pressure, must ascend so far as to compensate for this Diminution of Gravity, by the Attraction of the Glass: and this Power of Attraction in the Tube, being found by Observation to be always in the reciprocal Ratio of the Diameter of the Tube, by lessening the said Diameter, or by taking  
or

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or supposing Tubes still smaller and smaller, Water, or any other Fluid, may be thus raised in small open Tubes to any given or assigned Height. And since in this case the Fluid ascends, contrary to the Force of Gravity, 'tis manifest this attractive Power in the small Particles of Matter, must be superior to the Weight or gravitating Force of the same Particles, towards the Centre of the Earth.

5. LET a Drop of Oil, Water, or other Fluid, be laid on a glass Plane perpendicular to the Horizon, so as to stand without breaking or running off; and let another glass Plane, inclined to the former, be brought to touch the Drop: then will the Drop break and ascend towards the touching End of the Planes; and by altering the Angle of Inclination, the Drop may be directed to any part of the horizontal Plane at pleasure: which evidently demonstrates the same Power of Attraction in the small Particles of Matter, as in the foregoing case of the Ascent of Liquids thro' small open Tubes.

6. A GLASS or other Tube of any Diameter, fill'd with Sand, Ashes, or other such like porous Substance, and one End of the Tube so fill'd, being immersed in Water, the Fluid will ascend thro' the Sand, Ashes, &c. and fill all the Pores and Interstices of the whole super-incumbent Column. For in this

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case, the Pores and Interstices between the small contiguous Particles of the Sand, Ashes, &c. effect the same thing with the small Tubes in the case foregoing; and the Fluid ascends against the Force of Gravity, by the superior Power of a different Attraction.

THESE Observations and Experiments, to mention no more here, are sufficient to demonstrate the Truth of the *Proposition* in Fact; that there is such a Power or Force of Attraction in the very small Particles of Matter, exerting itself at or extremely near the Point of Contact, that is much superior to the Force of Gravity, and capable of determining those small divided Parts of Matter, in a different, or even quite contrary Direction to that of their own Weight.

### COROLLARY I.

THIS Power or Force of Cohesion, in the very small Particles of Matter, increases, as the Bulk and Weight of the Particles diminish. For since the Force of which we are now speaking acts only at or near the Point of Contact, 'tis evident that the Moment or Quantity of Force, must be as the Quantity of Contact; that is, as the Density of the Particles, and the Largeness of their Surfaces. But the Surfaces of Bodys in proportion to their Soliditys, are as their Diameters, inversely: for the Surfaces increase or decrease as the Squares, but the Soliditys as the Cubes of the Diameters. And consequently the  
smallest

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smallest Particles having the largest Surfaces, in proportion to their Soliditys, and being capable of touching other Particles in more Points, will have the greatest attractive Forces in proportion to their Weight. And hereby this Power of Attraction in the small Particles of Matter, being increased as their Bulk and Weight are diminished, such small Particles will be capable of receiving any given Direction by this Power of Attraction, just after the same manner as if they had no Gravity or Weight at all.

### COROLLARY II.

UPON this Power of Attraction, the various Degrees of Cohesion in the Parts of Bodys plainly depend, and may easily be accounted for: this Cohesion being ever proportional to the Quantity of Contact, in the immediately contiguous Particles.

### COROLLARY III.

FROM this Force of Cohesion, or Attraction of the small contiguous Parts of Matter, all the Appearances of elastick Bodys will follow, and may be easily explain'd. For where the small contiguous Parts of any compound Body, which unite and strongly cohere by immediate Contact, are, by any external Violence, as striking, stretching, or the like, forced or driven from their Points of Contact to extremely small Distances; after any such external Force is taken off, the separated

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parated Particles will by this Power of Attraction return to their prior Contact; by which means the Body will recover its former Figure. But if by any such Force the contiguous Parts are separated at too great Distances beyond their Power of Attraction, they will remain in that state of Disjunction, and be incapable of recovering their former Position and Contact; or, which is the same thing, the Spring or elastick Force of such a Body, will be weaken'd, broken, or perhaps quite lost.

## COROLLARY IV.

IF any Mass of Matter, consisting of Parts which attract and cohere, be immersed in a Fluid, and if the Parts of such immersed Matter be more strongly attracted by the Fluid, than they are by one another; such Parts will mutually recede from each other, and be equally diffused thro' the Fluid: and this sort of Solution, Separation and Diffusion, may be consider'd as a sort of centrifugal Force in the Parts of the Body which are thus separated and diffused; tho indeed, it arises only from the Excess of one Attraction above another. And this is doubtless the Cause of the Solution and Diffusion of Salts in Water: For the constituent Particles of the Salts being more strongly attracted by the aqueous Particles than by one another, their Cohesion must be broken, and the saline Particles will recede from each other, with a Force proportional

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tional to the Excess of Attraction in the Parts of the Fluid. But whether the centrifugal or expansive Force of the Air, be owing to the stronger Attraction of another Medium, namely, the Medium of Light or elementary Fire, in which the Air is as it were immersed and retain'd, must be submitted to farther Inquiry.

### S C H O L I U M.

No Observations or Experiments hitherto made, have been sufficient to determine the particular Law of Attraction in these small contiguous or cohering Parts of Matter ; only thus much is certain, that this Force in receding from the Points of Contact, is diminish'd in a greater Proportion than that of the duplicate Ratio of the Distances, which is the Law of Gravity. For where Corpuscles attract each other in the reciprocal duplicate Ratio of their Distances, their Force of Attraction at any small assignable Distance, will be nearly the same as at the Point of Contact. But 'tis manifest from all Observation and Experience, that this Force of Attraction and Cohesion in the Parts of Bodys, is exerted only at or extremely near the Point of Contact ; and at any sensible assignable Distance it vanishes, and has scarce any Effect at all.

Now by *Prop.* 90, 91. *Lib.* 1. of *Newton's Principia*, if Corpuscles attract each other mutually, in the reciprocal triplicate Ratio  
of

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of their Distances, the Force of Attraction at their Point of Contact, or infinitely near it, will be infinitely greater than when they are at any given or assignable Distance; and according to this Law, which seems to obtain, at least very nearly, in the small contiguous and cohering Parts of Bodys, if this Force of Attraction at the Point of Contact be not infinitely greater than the Force of Gravity, at any given or assignable Distance, it will be infinitely less than that of Gravity.

BUT tho this Attraction in the cohering Parts of Bodys, be vastly greater than the Force of Gravity, yet it still retains some finite assignable Ratio, and is not infinitely greater; because the Parts of Bodys which have the strongest Cohesion, may be separated by a finite assignable Force: and consequently this Force, which at the Point of Contact has still some assignable Ratio to the Force of Gravity, at any given Distance from the Point of Contact, must quite vanish, or become infinitely small.

PROPOSITION XXXV.

*ELEMENTARY Fire and Air act and re-act mutually upon each other: that is, the Air is expanded and rarefy'd by Heat, which is the Action of Fire; and Fire is excited and put into its most violent and rapid Motion, by the Expansion of the Air.*

IT has been found, by the most numerous and accurate Experiments, that the Atmosphere, or common Air, is a compressible and expansive Fluid ; whose Density is ever proportional to its Compression : And therefore the centrifugal or expansive Force of the Air, by which its constituent Parts endeavour to recede, or fly off from each other, must be in the reciprocal Ratio of their Distances, or in the direct subtriplicate Ratio of their Densities, by *Prop. 18. Lib. 2. of Newton's Principia.*

THIS is to be understood of the Air in its natural state, and abstracting from the Action of Light, or elementary Fire. But by the Action of this last Fluid, the centrifugal or expansive Force of the Air may be vastly increased, beyond the foregoing Ratio of its Compression and Density.

'TIS well known, that a small Portion of Air, included in a Bladder or any close Vessel, may, by Heat or the Action of Fire, have its expansive or centrifugal Force increased to a prodigious degree ; and that by this means, any Quantity of Air may be suddenly and violently rarefy'd and expanded, so as to fill above twenty thousand times the Space it possess'd before : and indeed, what else are all the surprizing Effects of Gun-powder, or those terrible Shocks and Convulsions which are call'd Earthquakes, but the natural Force and sudden

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sudden Expansion of imprison'd, heated, and rarefy'd Air?

ON the other hand, Air loses its Elasticity and expansive Force, in proportion as it is depriv'd of the Light, or elementary Fire which it imbibes and retains. For as the Elasticity of the Air is increas'd in proportion to the elementary Fire it contains, and the Motion it is put into; so the total absence of this Element, and the privation of its Action or Motion, would undoubtedly destroy that property of the Air, and leave it without any Elasticity or expansive Force at all. 'Tis evident likewise on the contrary, that Light or Fire loses all its Motion or Action, and is presently reduced to a state of Rest, as soon as it is depriv'd of Air. For such is the incredible fineness and tenuity of this elementary Fluid, that it might easily, even in its most rapid Motion, penetrate the Pores of all Bodys, without making any Change or Alteration upon them, were it not for the Air which they contain; which being a grosser Element, and being put into Action by Fire, is capable, by its vast expansive Force, to dissolve and separate the most strongly cohering Parts of mix'd Bodys.

I MIGHT here enumerate many particular Observations and Experiments, to evince this mutual Action and Re-action of elementary Fire and Air upon each other, and to shew the Necessity of both of them conjunctly, in order to the proper Efficacy and Effect of either:

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ther: but the Matter is too plain in fact to need any long or tedious Proof; tho the manner of it may not perhaps be so easy to account for.

### PROPOSITION XXXVI.

*THE attractive cohesive Power of the small Parts of Matter, as explain'd at Prop. 34. is the universal Principle of Rest, Concretion, and Fixation in Bodys; and the expansive Force of heated Air, or the mutual conjunct Action of Fire and Air, as in the last Proposition, is the universal Principle or natural Cause of Fermentation, Dissolution, and Fluidity.*

UPON the different Proportion and Adjustment of these two opposite Forces, with respect to each other, the different internal Constitution, Texture, and Cohesion of Bodys, will plainly depend; and may accordingly be judg'd of and estimated.

BY the attractive cohesive Force, as at Prop. 34. where that alone should be supposed to act, the constituent Parts of all compound Bodys must be brought to their nearest and greatest Contacts, where they would remain at absolute Rest among themselves, and be fix'd into solid cohering Masses; whose Soliditys, Densitys, and Degrees of Cohesion, must in this be proportional to the Quantitys of Contact in the immediately contiguous and cohering Particles: and therefore, by the sole  
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Presence and Action of this attractive Force, 'tis manifest, that all Fluidity must be absolutely destroy'd ; all the Fermentation or intestine Motion of the Parts of compound Bodys must cease, and all such Bodys would remain fix'd and unchangeable in a State of internal Rest and Solidity, without any Corruption, Solution, or Dissipation of their Parts.

ON the other hand, if this attractive cohesive Force be laid aside, and the centrifugal expansive Force of elementary Fire and Air, only consider'd or supposed to act ; the consequence of this must be, that all Bodys, even the most compact and solid, must immediately be dissolved, dissipated, and diffus'd, so as to constitute one general and perfectly fluid Mass, without any Distinction, or different Cohesion of Parts ; which one general mix'd confus'd Fluid or Chaos, would yet still be retain'd within a certain Orb or Sphere, by the Gravity or Weight of its Parts to their common Centre.

HAVING thus consider'd the different Effects of these Forces, while one or the other of them is supposed to act separately and apart, it will be now easy to shew, that all the different Constitutions and Cohesions of Bodys, their various degrees of Solidity and Fluidity, with the several Changes and Vicissitudes they undergo, while the Corruption and Dissolution of some continually make way for the Generation and Concretion of others, in the  
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beautiful Course and Order of Nature ; must be all owing to the different Proportions and Adjustments of those Forces, acting conjunctly under certain Conditions and Laws. Where these opposite Forces, in the Constitution of any Body or compound Mass, are respectively equal ; 'tis manifest, that such Body or Mass must continue in, or preserve its present state of Solidity, Fluidity, or Degree of Cohesion : since in this case the Quantity of Contact must continue the same, and the constituent Parts can neither approach nearer to, nor recede farther from each other ; that is, the Body, with respect to the internal Constitution, Texture, and Cohesion of its Parts, can admit of no change.

IF the Power of Attraction prevails against the contrary centrifugal diffusive Force, the constituent Parts will be brought nearer to each other, till they have obtain'd the greatest Quantity of Contact they can admit of ; and there they will rest in a certain degree of Solidity, Fixation, or Force of Cohesion, proportional to such Quantity of Contact.

BUT if the expansive Force of the elementary Fire and Air, included in any Body or Mass of Matter, prevails against the attractive Power of the contiguous Parts ; the Parts which constitute any such Body or Mass, must recede from their Points of Contact : and this happening thro' all the Subdivisions of which the Body or Mass is capable, every small Part must be divided and separated into  
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other smaller Parts, and these again into others, and so on, till we come to the first constituent Particles, which perhaps cannot be divided farther. And this Recess of the Parts of Bodys from their Points of Contact, and their consequent separation and division into their minuteft constituent Particles or Corpuscles, is what I call *Rarefaction*: and on the contrary, the approach of the Parts nearer to their Points of Contact, by the prevailing Power of Attraction and Cohesion, is what I understand by *Condensation*. Now from the contrary Efforts of these two Forces, while the constituent Parts of Bodys, which have a continual *Nifus* or *Conatus* towards the Points of Contact, are forced off by the expansive Power of the foregoing Elements, there must necessarily ensue an intestine Commotion, Collision, and mutual Struggle of the Parts among themselves: that is, the Parts acted by two such opposite Forces, will fly off and recoil, recede and accede, in proportion to the Strength and Energy of those opposite Powers, till one or the other prevail, either to fix and condense the Body, or to dissolve and diffuse it: and in this Sense I would be always understood, when I talk of the *Fermentation*, or intestine Motion of Bodys.

Now where the attractive cohesive Force in Bodys, prevails against the contrary Power of the expansive Elements to any considerable degree, the most fluid and fluxile Bodys will

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will be immediately fix'd and consolidated; as is evident in the case of Water, and other Fluids turn'd into Ice; which happens thus: The elementary Fire and Air contain'd in the internal Constitution, or within the Pores and Interstices of such Fluids, being reduced to a state of Rest, there ensues a Sense of Cold, which is only the sensible Appearance or Indication of Rest in those Elements; upon which the attractive Power of the constituent Parts, prevailing against the contrary expansive Force, the Fluid is presently fix'd and consolidated, till the expansive Elements are again put into Motion; which reduces it to its former state of Fluidity.

ON the other hand, by the Action of the expansive Elements, the most fix'd and solid Bodies are dissolv'd, and their Parts separated, broken and diffus'd; of which the Instances and particular Proofs are innumerable. But I shall only exemplify the general Case, from the single Instance of the Solution of Iron in *Aqua fortis*; because accounting for this, will explain the manner of all the rest.

'TIS well known, that any Parcels or Quantity of Iron, being immers'd in *Aqua fortis*, there will immediately ensue a strong sensible Fermentation, Effervescence, and Ebullition of the Fluid, with great Heat, Fumes and Evaporations; during which, the solid compact Body of the Iron is perfectly dissolv'd, divided into the minutest Parts,

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and equally diffus'd thro', and suspended in the dissolving Menstruum ; which, upon the Principles already laid down, is thus accounted for. The *Aqua fortis* immediately rushes into the Pores and Interstices of the immersed Iron, and is strongly attracted and retain'd by the Parts of the Mineral : from whence the Air, which before possess'd and fill'd up those Pores and Interstices, having now less Space to expand, must be forcibly compress'd and condens'd ; in consequence of which Compression and Condensation, the included Air exerts its elastick Force, by a strong *Conatus* to expand and fill the same Space as before ; which being resisted by the attracted compressing Menstruum, there must ensue a Fermentation or intestine Motion of the Parts ; by which the elementary Fire contain'd in, and diffus'd thro' the Substance of the Iron, being excited and put into Motion, heats and rarefys the Air, and increases its elastick expansive Force : and the heated rarefy'd Air, thus exerting a stronger elastick Force, communicates a more violent and rapid Motion to the included elementary Fire, till by the mutual Action of these Elements upon each other, the expansive Force is increased beyond the attractive Power of the Parts of the Iron ; and then the attracting cohering Parts of the Mineral must necessarily recede more and more from their Points of Contact, and being separated and divided into the minutest Particles, will be dissolv'd and

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and diffus'd in the *Aqua fortis*. For it must be here observ'd, that the Gravity or Weight of the exceedingly minute Particles, into which the dissolved Body is thus divided, being less than the attractive Force of the Parts of the Fluid or dissolving Menstruum, as at *Prop. 34.* this attractive Force of the Fluid suspends such extremely small Particles, and retains them in any given Position against their Force of Gravity. After the same manner, the Effects of all other dissolving Menstruums, as they depend upon the same Cause, are equally to be understood and accounted for. Upon the whole therefore, as the attractive cohesive Force of the small Parts of Matter in compound Bodys, is the universal Principle of Rest, Concretion, and Fixation; so the expansive Force of heated Air, or the mutual conjunct Action of elementary Fire and Air, is the universal Principle and natural Cause of Fluidity, Fermentation, and Dissolution.

S C H O L I U M.

FROM the Principles laid down in the three last *Propositions*, the ascent of Vapours or small Particles of Water, and other heavier Bodys in Air; the ascent of the Sap from the Roots thro' the Bodys of Trees and Vegetables of all kinds; the Circulation of the Blood thro' the extremely small Capillary Arterys; the Passage of the Lymph or Serum thro' the minute glandular *Tubuli*, and thro'

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the vascular *Fibrillæ* which constitute the Bones, with other such like Appearances and Phenomena of Nature, may easily be explain'd and accounted for.

THOSE who have endeavour'd to account for the ascent of Water, Quicksilver, and Bodys specifically heavier than Air, in the form of Vapour, only upon the Principles of Hydrostaticks, have been forc'd to fly to mere precarious Hypotheses, and such as could never possibly be evinc'd as true in fact. But not to spend much time here in the Refutation of a false Hypothesis, a little Consideration will be sufficient to shew, that this ascent of heavy Bodys in the form of Vapour, cannot be owing to any Action of Gravity, Weight, or Pressure whatever.

'Tis commonly known, that any Body being immers'd in a Fluid, if its specifick Gravity be the same with that of the Fluid, it will every where rest in it, or retain any given Position, without ascending or descending. If the immersed Body be lighter than an equal Bulk of the Fluid, the Body will ascend to the Top, and remain in part above the common Surface, till a compound Column, consisting of the Fluid and the lighter Body together, be of equal Weight, or press equally on the Base or Bottom, with a Column of the pure Fluid. But if the immersed Body be specifically heavier than the Fluid in which it is immers'd, it must, by the necessity of its Weight, sink to the Bottom, and remain there,

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there, unless it be rais'd and suspended by some other Force. In the same manner, and for the same reason, if several Liquors, differing considerably in specifick Gravity, and which cannot readily mix, be put into the same Vessel, they will take place according to their Densities; the heavier remaining at Bottom, and the lighter ascending towards the Surface.

Now all that is done by Rarefaction, or the expansive Power of heated Air, as has been shewn, is only to force the small Parts of Bodys farther from their Points of Contact, and thereby to separate and divide them into other smaller Particles; but each separated small Particle will retain the same specifick Gravity, with any greater Quantity or Portion of the same Mass: and therefore, since any small Particles of Water, which may be separated by Rarefaction from a larger Mass, are 14 times, and those of Mercury 12000 times heavier than an equal Bulk or small Portion of Air, they cannot possibly ascend and be suspended in it, by any Law of Weight or Pressure. And yet we know, that even Mercury itself, notwithstanding its great Density, will, with the assistance of a little Heat, quickly run all into Vapour, and fly off in the Air.

BUT from that other Principle or Law of Attraction in the small constituent Parts of Bodys, demonstrated at *Prop. 34.* this Phenomenon will be naturally explain'd, and ea-

sily understood: for since this cohesive Force, by which the small contiguous Parts of Matter attract, unite with, and run into one another, increases as their Weight diminishes; that is, as the Surfaces increase in proportion to the Solidity, or inversely as the Diameters; 'tis evident this corpuscular Attraction may be increased, and the Weight or Gravity diminish'd, till the latter vanishes, or becomes of no moment at all with respect to the former. In which case, the very minute Particles of Water or other Fluids, separated and divided by Motion, Rarefaction, or otherwise, will be attracted and as it were absorb'd by the contiguous Parts of the Atmosphere, as Water ascends in small Tubes, or thro' a Column of Sand, Ashes, &c. for where this corpuscular Attraction takes place, it acts upon those very minute Particles, by attracting them any way, or every way indifferently, perpendicularly as well as horizontally; just after the same manner, as if they had no Weight or Gravity at all.

'Tis manifestly from the same Power or Principle of Motion, that the Sap rises from the Roots, thro' the exceedingly minute vascular Fibres or *Tubuli*, of which the Trunks and Bodys of Trees and Vegetables are compos'd. For since a Fluid will rise in a small open Tube of a given Diameter, to a given Height; and since this Height is by Observation ever in the reciprocal Ratio of the Diameter;

meter ; 'tis plain that a Fluid, by this means, may rise in small Tubes to any given Height, provided the Diameter of the Tube be proportionally lessened.

AFTER this, it can hardly be doubted, but that the Blood in animal Bodys circulates thro' the Capillary Arterys, and thro' the extremely minute glandular Strainers, and the almost infinitely small vascular *Fibrillæ* of the Bones, by the same Force, and upon the same Principle and Law of Motion. That this may be done without any thing of muscular Force and Motion, is evident from the Circulation of the Sap from the Roots, thro' the solid Trunks and Bodys of Trees, in the Case just now consider'd : but tho the Circulation of the Sap be a thing evident in Fact, and plainly accounted for by this Principle or Law of corpuscular Attraction ; yet it would be impossible by any Force of Impulse or Pressure whatever, to drive Water thro' the Trunks or Bodys of Trees ; and equally impossible must it be, to drive the Blood and animal Liquors, by any mere Force in the Muscles, thro' such numberless and almost infinitely small *Tubuli*, which are infinitely divaricated, contorted, and branch'd out into all possible Directions.

BUT besides the numberless exceedingly minute and infinitely divaricated *Tubuli*, which constitute the fleshy Parts of an animal Body, and where only there is any muscular Force or Action to be found ; 'tis cer-

tain, in fact, that the animal Liquors circulate and pass freely thro' the minutest vascular *Fibrillæ* of the most solid and compact Bones: and to imagine that this Circulation and Passage of Liquors thro' the Bones, is owing to the impelling protruding Force of the Muscles, must, I think, be a Point of Belief almost beyond the Power of the most credulous.

THAT the Force and Action of the Muscles have a principal Share in propelling the Blood and animal Fluids thro' the larger and more open Vessels, and likewise contribute by a gentle squeezing to empty the minute fleshy *Tubuli* of their contain'd Fluids, I shall prove hereafter in its proper place: but that these extremely minute vascular Canals and Strainers should be fill'd with their proper Liquors by any such protruding Force of the Muscles, is as impossible as it would be to propel, or drive Water from the Root thro' the solid compact Body or Trunk of an Oak; which is what cannot be done by any Force of Impulse, Protrusion, or Pressure whatever.

#### PROPOSITION XXXVII.

*THE expansive or centrifugal Force of heated rarefy'd Air, separates and dissolves the Parts of solid Bodys; and intimately mixes and blends together the Parts of Fluids, so as to hinder the Separation of their heterogeneous Particles.*

THAT

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THAT the expansive Force of the elementary Fire and Air, retain'd in the internal Constitution of Bodys, is the universal Principle of Corruption, Diffolution, and Fluidity in Bodys ; and that this Force, when it prevails over the corpuscular Attraction, dis-unites and separates the cohering Parts of the most solid and compact Bodys, is sufficiently manifest, from what has been already prov'd in the two last *Propositions* ; and that the same expansive rarefying Power, intimately mixes, blends, and unites the heterogeneous Parts of Fluids, and hinders their Separation, is evident in Fact, from the commonly experienc'd and well-known Effects of Rarefaction and Fermentation in Liquors. For while this Rarefaction and Fermentation continues, Corpuscles of the most different Densitys and specifick Gravitys contain'd in the Fluid, are intimately mix'd and confusedly blended together, and no separation can be made.

BUT as the expansive Force lessens, and the corpuscular Attraction prevails, the denser and more solid Corpuscles unite, cohere, and form larger Corpuscles ; which being separated from the Fluid, and subsiding or taking place according to their specifick Gravity, the Liquor refines and settles. After which Separation, Condensation, and Subsidence, any Heat or Perturbation of Motion, which exerts and puts into Action the expansive elastick Elements, will again raise the Sediment,

ment, and mix, confound, and blend the most different and heterogeneous Particles, as before: and while the denser and more solid Corpuscles, whose Attraction and Cohesion are greatest, are by this means rarefy'd and enlarg'd, they absorb or take up a great of the Fluid, and render the whole Mass thick, viscid, and tenacious.





# *Philosophical Principles*

O F

# M E D I C I N E.

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## P A R T II.

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Containing the more particular L A W S  
which obtain in the Motion and Se-  
cretion of the vital Fluids, apply'd to  
the principal Diseases and Irregula-  
ritys of the Animal M A C H I N E.

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### PROPOSITION I.



*THE Blood Globules are specifically  
heavier than the Serum, and consist  
of Particles, which are endu'd with  
a stronger corpuscular Attraction,  
and which receive and retain a  
greater degree of Heat.*

'T I S

'TIS commonly known, that the Blood of Animals, when view'd with a Microscope while it circulates in its proper Vessels, appears to consist of numberless very minute red Globules, or *Spherulæ*, swimming in, and equally diffused thro' a thin pellucid Water, Lymph, or Serum: These two different Substances, tho of unequal specifick Gravities, yet while they continue to circulate in the Veins and Arterys, are equally mix'd and blended together, and kept from separating by the Heat and Motion of the Blood, and the continued Action of the expansive Element, as explain'd at *Prop. 36, 37. Part I.*

BUT any Quantity or Portion of this compound Mass, being let out of its containing Vessels and receiv'd in a Bason or Porringer, and there suffer'd to remain at Rest, that the Parts may take place according to their specifick Gravities; the Globules uniting by their corpuscular Attraction, will sink to the Bottom, and there form a *Crassamentum* or coagulated Sediment, while the Serum will ascend and swim above it. And this, which is a plain Matter of Fact and common Observation, evidently shews, that the Globules which form the *Crassamentum* or Sediment, must be denser or specifically heavier than the Serum.

THIS is generally the case in Fact, as every body knows; tho it sometimes happens, that either by the Glutinosity of the *Crassamentum*,

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*mentum*, sticking to the sides of the Porringer, or by reason of adventitious Bubbles of Air, which the Blood gathers while it flows from the Orifice, the *Crassamentum* will be kept from subsiding, and seem to swim upon the Top of the Serum. But even in this case, the Adhesion of the *Crassamentum* to the sides of the Vessel being broken off, and the adventitious Air suffer'd to evaporate, the *Crassamentum* by its greater Weight and Density will sink to the Bottom, and the Serum remain above it, as before.

THE observing that one of these Globules, while it passes a small capillary Artery, will dispose itself into an oblong Spheroid, and recover its spherical Figure, as soon as it is got out of that narrow Passage; has induc'd some to conclude, that these Globules are thin Vesicles, or Bubbles blown up and distended with Air; and that the Restitution of the Globule to its former Figure, after it had been put out of it, must be owing to the elastick or expansive force of the included Air. But this Restitution of the Globules, is plainly to be refer'd to another Principle; that is, to the corpuscular Attraction of their constituent Parts, by *Prop. 34.* by which all such small Portions of Matter, provided they are soft and yielding, that is, fluid enough, will be reduc'd to little Drops or *Spherulæ*.

THUS let a Drop of Oil, or any other viscid Liquor, be plac'd upon an horizontal Plane, and gently press'd perpendicularly by another

another Plane, and the Drop by such Pressure will be reduc'd to an oblate Spheroid, and presently assume its spherical Form again, as soon as the upper Plane is taken off, and the Pressure remov'd; and this by the corpuscular Attraction of its Parts, without any thing of Elasticity or Expansion by included Air: but that these Globules are not elastick Bubbles or Vesicles fill'd with Air, will be still more evident from the following Observations.

1. UPON drawing off any Quantity of Blood into a Porringer, as the Blood cools, and the Globules unite by their mutual Attraction, in order to the Separation and Subsidence of the *Crassamentum*, one may plainly perceive, especially by the help of a Microscope, that as the Globules press each other in their nearer Contacts, very considerable Quantities of Serum will be forc'd or squeez'd out of their Pores and Interstices, but no Air: which manifestly shews that their Cavities were before fill'd and possess'd, not with Air, but with Water, Lymph, or Serum.

2. IF these Globules are Bubbles or Vesicles blown up and distended with Air, let us suppose the external Vesicle or Shell to be a third Part of the whole Globule; which is a very liberal Allowance, with respect to Bubbles, whose Vesicles are commonly extremely thin: then if the Globules, while distended and swimming in the Blood, be equal in Quantity to the Serum, which is a moderate Supposition, and agreeable to Experiments;  
before

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before the Globules can sink, the Air contain'd in them must evaporate and fly off, which being  $\frac{2}{3}$  of the Bulk of the Globules or  $\frac{1}{3}$  of the whole Mass, it must follow from hence, that Blood when cold, and the *Crafsamentum* subsided, must lose  $\frac{1}{3}$  of its former Bulk, still retaining the same Weight: that is, three Pints of hot Blood fresh drawn off, would, when cold, be reduc'd to two Pints; and its specifick Gravity be increas'd in the same Ratio of 3 to 2. But 'tis certain that no such thing happens in fact, and that the Blood, when cold and settled, still retains very nearly the same Bulk and specifick Gravity.

SOME small difference there will indeed be, on the account of the Blood's Rarefaction while hot, and its Condensation when cold; and which is common to the Blood with all other Liquors: but by this Cooling and Condensation, the Blood increases its specifick Gravity, only in the Proportion of 527 to 526, or thereabouts, as has been found by Experiments.

3. THE Blood-Globules in a Vacuum, retain the same Size or Magnitude as in the open Air, as Experience testifies; but were they Bubbles or Vesicles fill'd with Air, they must either in this case break by the great Expansion of their included Air, or at least be blown up to 70 or 80 times their former Bulk.

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WHAT has been said, is abundantly sufficient to demonstrate, that the Blood-Globules or *Crassamentum*, is specifically heavier than the Serum; and that consequently being more dense and compact, must consist of Parts which are endu'd with a stronger corpuscular Attraction: and as the *Crassamentum* consists of heaviest and densest Parts, so it must in consequence be capable of receiving a greater Degree of Heat, and of retaining the Heat it once acquir'd longer than the Serum, which is of a more loose and open Texture.

BUT for the particular proportional Densities, or specifick Gravities of Blood, Serum, *Crassamentum* and common Water, the World is exceedingly indebted to the accurate Observations and Experiments of the learned Dr. *Jurin*, of which he has given us an Account in the *Philosophical Transactions*, N<sup>o</sup> 361. where by comparing and adjusting his several Experiments, and taking a mean Proportion, he finds that the specifick Gravities of Blood, Serum, and common Water, are as 1054, 1030, and 1000 respectively. From whence again it must necessarily follow, that the *Crassamentum* is specifically heavier than the Serum; because this being separated from the Blood, leaves the Remainder specifically lighter than the mix'd or compound Mass.

THE Blood-Globules in their natural state, are plainly of a loose, open, and spongy Texture, and contain in them a considerable Quantity of Serum; which being drawn off by

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by Distillation, is found to be strongly ting'd with Oil and volatile Salts, and its specifick Gravity is to Water, as 1080 to 1000. But the specifick Gravity of the dry'd *Crassamentum*, after its contain'd Serum is drawn off, is as 1280: and by comparing Experiments, and taking a mean Proportion, the specifick Gravity of the Blood-Globules in their natural state, as determin'd by Dr. *Jurin*, is as 1126.

S C H O L I U M.

THIS greater specifick Gravity of the Blood-Globules, is to be understood of a natural, sound, and healthy State, and where they retain their due Proportion to the Serum; that is, where the *Crassamentum*, when subsided and settled in a Porringer, is nearly equal to the Lymph which remains above it. But in a weak and languid state of the Constitution and Blood, where the *Crassamentum* bears but a small Proportion to the Serum, its specifick Gravity will be lessen'd with its Quantity, as I have often found by Experience: for in Girls under a *Chlorosis*, and in hydropical People, whose Blood runs mostly into Serum, I have sometimes met with the remaining *Crassamentum*, of equally specifick Gravity with the Serum itself, which would continue to float freely about it, even after the Blood had stood and settled in a cold Place for a Day or two. But in Fevers, which come on by Depletion, or make their Attacks after any

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great Evacuations of the Serum; the Blood, or mix'd Mass, is often specifically heavier than in its natural State; because it contains a greater Proportion of the *Crassamentum*, while the *Crassamentum* itself is specifically lighter than before, as being more heated and rarefy'd.

PROPOSITION II.

*THE Crassamentum or globular Part of the Blood, is a standing or fix'd Quantity; and is not at all increas'd or diminish'd by the Augmentation or Diminution of the glandular Secretions.*

THAT all the natural Secretions consist of certain Portions of the Lymph or Serum, drawn off from the Blood in the Arterys by very minute *Tubuli* or Strainers, which are too small to admit the Blood-Globules, is most certain in Fact, and well known to every one who has the least acquaintance with the Animal Oeconomy. Bloody Secretions, or such as are ting'd and mix'd with the Globules, are always preternatural, and never happen but in a morbifick State. Since therefore all the natural Secretions are drains from the Serum, 'tis plain that the Serum of the Blood only, is increas'd or diminish'd in proportion to the Secretions; while the *Crassamentum* remains the same as to its absolute Quantity, under any proportional Augmentation or Diminution of the glandular Secretions.

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SCHOLIUM.

THIS Proposition considers the Crassament, only with respect to the Evacuations by Secretion, which may be increas'd or diminish'd, while the globular Part of the Blood as to its absolute Quantity remains the same: but from other Causes, 'tis plain that the *Crassamentum* may be increas'd or diminish'd in its absolute Quantity, together with the Flesh, Fat, and other more solid Parts of the Body. Thus in the Nourishment and Growth of Animals, the Crassament ought to increase proportional to the Serum, for otherwise the due Constitution, Texture, and Consistence of the Blood would be lost; which must introduce a morbid State. In weak and languid Constitutions, we see the *Crassamentum* is often wasted and wash'd off, together with the Flesh and Fat, while the Serum abounds in too great a Quantity.

IN other morbid Cases, the Serum runs off too fast in the Secretions, while the globular Part remains in a very great and undue Quantity and Proportion: a remarkable Instance of which, I met with in a Gentlewoman, who, at about the Age of fifty, dy'd of a dry Asthma. She was continually afflicted for four or five Months with a melting wasting Heat, her Pulse being very small and quick; from a Pint of whose Blood, after it had stood a whole Night in a frosty Season, tho it had been very much condens'd with the Cold,

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and the *Craſſamentum* was ſunk to the Bottom of the Porringer in a hard compact Subſtance, yet there did not remain on the Top, which could be pour'd off, above  $2\frac{1}{2}$  Ounces of Serum: and when Blood was taken from the ſame Gentlewoman in a warmer Seaſon, it would ſcarce ſeparate or throw off Serum enough to cover the Surface of the ſubſided *Craſſamentum*, after it had ſtood and ſettled for a long time.

Now if we ſuppoſe the Blood-Globules, after their Subſidence, to retain their ſpherical Figure, the Serum contain'd within their Interſtices, would be nearly equal in Quantity to the Globules themſelves: But becauſe the Globules when ſubſided muſt attract, and preſs upon each other, they muſt be ſuppos'd to touch, not barely in mathematical Points, but in ſmall physical Surfaces; and therefore, the Quantity of Serum contain'd within the Pores and Interſtices of their touching Points, muſt be ſomewhat leſs; and conſequently the *Craſſamentum* muſt have been nearly equal to the Serum: and yet the Blood-Veſſels in this caſe appear'd to be moderately full, and ſenſible Secretions were not large; from whence it muſt follow, that the abſolute Quantity of the *Craſſamentum* contain'd in this Maſs of Blood, muſt at leaſt have been double to what is uſual in a ſound confirm'd ſtate of Health.

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PROPOSITION III.

*TO find the absolute and relative Velocity of the Blood.*

By the absolute Velocity of the Blood, I here mean that which it obtains at the Heart, or in the *Aorta*, before its Ramification and Division into Branches: and by the relative Velocity, I understand that which it obtains at any given Distance from the Heart, after any assignable number of Branches or Ramifications.

Now if the Sum of the transverse Sections of the Branches and Ramifications of the *Aorta*, were every where equal to the Section of the main Trunk itself, 'tis manifest, that the Velocity of the Blood in this case must be every where the same as in the *Aorta*. But since it appears in Fact and by Experiments, that the Sum of the Sections of the Atterys, at every Division, is greater than the Section of the common Trunk before the Division; it must from hence follow, that the Velocity of the Blood will be diminish'd at every Division, as the Canals enlarge, and in the same Proportion: and therefore the Ratio in which the Sections enlarge being given, the Ratio in which the Velocitys are diminish'd, will be likewise given.

FOR the absolute Velocity: The Quantity of Blood thrown out of the left Ventricle, in a given time, being divided by the transverse

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verse Section of the *Aorta*, will give the Length of the Canal, or the Space thro' which the Blood moves in the Time given.

THE left Ventricle, in its middle Size, is capable of containing between three and four Ounces of Blood: but it is not certain that this whole Quantity is empty'd into the *Aorta*, at every Contraction or Systole; and therefore I shall suppose, that during the Time of one Pulsation only, two Ounces of Blood is thrown into the *Aorta*; and that the Heart contracts 80 times in a Minute, and then there will be 160 Ounces pass thro' the *Aorta* in a Minute.

AN Ounce of Blood is 1,65 cubick Inches, and consequently 160 Ounces will be 264 cubick Inches. The Diameter of the *Aorta* is about 0,7 of an Inch; and consequently its Section will be 0,4 of an Inch: and 264, the Quantity passing in a Minute, divided by 0,4, gives 660 Inches or 55 Feet, for the Length of the Canal, or Space described by the Blood in a Minute. And after the same manner may the Velocity of the Blood in the *Aorta* be determin'd, upon any other Supposition of the Quantity passing in a given Time.

FOR the relative or respective Velocity of the Blood, after any given Number of Branches or Ramifications of the great Artery: Let the Velocity in the *Aorta* be call'd  $a$ , and the Ratio of the Trunk to the Sum of the Sections of any two Branches, call  $e$ : then  $a$  being the Velocity at the Heart, the Velocity  
after

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after the first Division will be  $ae$ ; at the second Division  $ae^2$ , at the third  $ae^3$ , &c. consequently at the thirtieth Division the Velocity will be as  $ae^{30}$ .

Now the most usual Proportion which obtains between the Sections of the common Trunk, and the Sum of the Sections of its Branches, as Dr. Keil found by many Observations and Experiments, is that of  $\frac{100}{124}$  nearly: upon which Supposition, let it be requir'd to find the relative Velocity of the Blood; for Instance, at the thirtieth Division the Logarithm of  $\frac{100}{124}$  is 9,9065783; which multiply'd by 30, the Index of the Power of  $e$ , gives 7,1973490, to which the Number answering in the Tables is 0,001575; and consequently the Velocity at the Heart, is to the Velocity at the thirtieth Division, as 1 to 0,001575; that is, as 1000000 to 1575, or as 635 to 1. And therefore, if the Blood in the *Aorta* moves 55 Feet, or 660 Inches in a Minute, at the thirtieth Division it will move but little more than an Inch in the same Time. In like manner, at the fortieth Division the Diminution of Velocity will be as 5456 to 1; at the fiftieth as 46882 to 1; and at the hundredth Division as 2200000000 to 1 nearly. This is upon the Supposition, that the Sections are augmented thro' all the Divisions of the Arterys, in the same constant Ratio of 124 to 100: but 'tis very probable, that a much less Ratio than this, must take place in the small complicated Arterys; and

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consequently, that the Diminution of Velocity cannot be so great as this Proportion would suppose it, tho the number of Divisions and Complications should be much greater.

### PROPOSITION IV.

*MUSCULAR Motion is perform'd by the intrinsic Elasticity of the nervous Fibrillæ, contracting and restoring themselves against the stretching Force of the circulating Blood.*

A MUSCLE is a Bundle of small Blood-Vessels, consisting of Arterys and their returning Veins, laid one upon another in very thin parallel Plates, running thro' the whole Length of the Muscle; these Blood-Vessels, or as they have been usually call'd, longitudinal, red, and fleshy Fibres, are every where at small Intervals, contorted and bound about with small, transverse, and spiral Ramifications and twinings of the Nerves, which Anatomists have commonly call'd, the white, spiral, and transverse Fibres.

A MUSCLE thus constructed, has its two Ends, call'd the Tendons, fasten'd to two Bones, one of which is fix'd and the other moveable; and by the Contraction of the Muscle, the moveable Bone is drawn upon its *Fulcrum* towards a fix'd Point. But before I proceed farther, it will be proper here to observe one remarkable Difference, between the Muscles of voluntary, and those

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of mere natural or necessary Motion, which is this; that all the Muscles of voluntary Motion have their Antagonists, which act alternately in a contrary Direction, the one being stretch'd and extended, while the other is contracted by the Power and Command of the Will. But the Muscles of bare natural necessary Motion, have their contracting, and extending or stretching Powers within themselves, and need no Antagonists. Now I shall in the first place consider what is in common to both these, as necessary and essential to all muscular Motion whatever, whether voluntary, or barely natural and mechanical. In order to which, I shall here demonstrate, as an evident Matter of Fact, that all the nervous Coats and Fibres which enter into the Structure and Constitution of the Muscles, are endu'd with an intrinsic Elasticity, Spring, or Power of contracting and restoring themselves, against a given Weight or Force by which they may be stretch'd; and, that this Elasticity, or contractive restitutive Power, being a natural inherent Property of the Fibres themselves, does not depend on the Mixture, Effervescence, or Rarefaction of any Fluids, Humours, or Liquors within the Body: this, I think, will abundantly appear plain in fact from the following Considerations.

1. 'Tis manifest, that all the Vessels in an animated Body, which consist of flexible distractile Fibres, are in a state of Tension; that is, they are both distended transversely  
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and stretch'd in Length, by the Quantity and *Momentum* of their contain'd Fluids : for let any such Vessel as a Vein or Artery, for instance, be cut transversely, and the Blood being let out, or hinder'd from flowing to the Wound by a proper Ligature, the opposite Sides of the Vessel will contract, and come nearly to a Contact about the Axis ; while the two Ends will recede both ways from the Point of Section, by the contractive Power of the Fibres, and leave an intermediate Chasm or gaping Wound : which makes it evident, that the Vessel, while it remain'd intire and in its natural state, was distended transversely, and stretch'd in Length, by the Quantity and Moment of the contain'd circulating Blood ; and consequently, Contraction in all their Dimensions, is the natural intrinsic Action of the Vessels or Fibres themselves : this Contraction therefore, is plainly the state to which the elastick Fibres tend by a continual *Conatus*, and to which they are presently reduc'd as their proper and natural state of Rest, as soon as they are freed from the distending stretching Force of the Fluids. And that the vascular or organical Parts of the Body, are proportionally enlarg'd in all their Dimensions by the Quantity and Moment of their contain'd Fluids, is farther evident from the Growth, or gradual Augmentation of Bulk in Animals : for every body knows, that by the increased Quantity and *Momentum* of the accumulated Blood and animal Fluids,

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the Vessels in their natural State and Growth are enlarg'd in proportion every way; that is, stretch'd in Length as well as distended and widen'd in Breadth or Thickness: this therefore is the proper and natural Action of the Fluids, to distend and stretch the vascular Parts, and enlarge them in all their Dimensions. Against the distending stretching Power of the Fluids, the solid muscular *Fibrillæ* continually exert a contractive or restitutive Force, by which they are kept in their proper and natural state of Tension, and without which they would immediately be relaxed, and become incapable of any Action at all.

2. THAT this contractive Power of the muscular Fibres, is a natural intrinsic Property of the Fibres themselves; and that it does not depend on any Mixture, or mutual Action of Fluids within the Body, is evident from hence, that these Fibres retain the same Property, after they are taken out of the Body and dry'd; as we see in Thongs, Cat-gut, and other such-like Cords or Strings, cut out of the muscular Coats and Skins of Animals, which may be stretch'd out to a considerable Length beyond their natural State; and when the stretching Force or Weight is taken off, they will immediately contract again, and recover themselves by their own native intrinsic Spring.

3. WHILE a Muscle contracts, the Blood is forcibly squeez'd out of it, and during its state of Contraction, it is more hard, compact,  
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and solid than before ; that is, it contains less Blood and Fluid in it when contracted, than when it is stretch'd and extended: which plainly shews, that this Contraction cannot be made by the addition of another Fluid from the Nerves, mixing with Blood in the Muscles.

'Tis well known, in Blood-letting, where a Section has been made in the Cephalick Vein, if the Blood does not flow free enough from the Orifice, the Velocity of the effluent Blood will be much increas'd and promoted, by clinching the Hand of the same Side, and bringing the Muscles of the *Carpus* into a strong Contraction: if this Contraction be long continu'd, the Velocity of effluent Blood will be sensibly abated by such continual bent ; but if the Fibres are unbended, and the Muscles contracted again, by turns, the increas'd Velocity and Impetus of the Blood from the Orifice will be restor'd, and may be kept as long as we please. This is the Matter of fact, and which happens thus ; the Blood with which the Muscles of the *Carpus* are fill'd and distended, while they are stretch'd and dilated, being forcibly compress'd and squeez'd out by the Contraction, is sent directly into the Subclavian Vein, from whence it flows out at the Orifice, and increases the Velocity.

If the Contraction be long continu'd, the Velocity will abate, and be but little, if at all, promoted ; at most, no farther than what may be

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be done by a small Quantity of Blood, which being suspended from entering the Muscles of the *Carpus*, now finds an easier and more open way thro' the Orifice. But if those Muscles be alternately contracted and extended, the increas'd Velocity of the Blood thro' the open Vein will be kept up; because in this case there is not only an increased Quantity of Blood sent to the Orifice, but a continual new Impetus given it by the contracting compressing Nerves. Every body knows the Power of Exercise, or any brisk voluntary Motion, in raising the Pulse and increasing the Velocity of the Blood; and how this comes about, is very evident from this Principle: for the Blood, forc'd with a new Impetus thro' those Muscles, by their repeated strong Contractions, must communicate its Motion to the rest of the Blood, till the Pulse gradually rises, and the Heat diffuses itself, as we find in fact.

BUT the most convincing experimental Proof of this, as true in fact, is from what may be observ'd in the Heart of a Dog, whose Thorax has been laid open, so as to give us a distinct view of that famous Muscle in its curious and wonderful Motion, while the Animal is still alive.

IN this case one may observe, that the Heart while it is in its Diastole, appears of a very red and florid Colour; 'tis sensibly soft and yielding to the Touch, the vital Fluid glows in it and shines thro' it; and in short,  
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all the Circumstances show, that in this state the Muscle is fully replenish'd and distended with Blood : but as soon as it begins to contract, one may observe the Blood with an increas'd Velocity, flowing out of its whole Substance, thro' the coronary Veins into the *Auricles*; and while the Blood thus rushes out, by the Compression of the contracting nervous Fibres, the Heart manifestly changes its former red and florid, into a much more pale and livid Colour; it is sensibly more compact and solid to the Touch, and every Circumstance concurs to evince, that in its Systole it contracts inwardly into its own Substance, and is more dense, or takes up less space than before.

THE Systole being over, and the Heart returning to its Diastole, the Velocity of the Blood thro' the coronary Veins is abated, and the Muscle recovers its former Redness, Floridity and Softness: from whence 'tis manifest, that in this case the Blood rushes into the whole Substance thro' the coronary Arteries, and inflates and stretches the Blood-Vessels, in order to bend or strain the Nerves for the next Contraction.

4. THE common Hypothesis, which derives a new additional Fluid from the Nerves, to be mix'd with the Blood in the Muscles, in order to their Inflation and Contraction, is not only contrary to all the foregoing evident Facts, but likewise plainly inconsistent with the Circulation of the Blood. For 'tis mani-

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fest by what has been here said, that the Blood in the Muscles, during their Contraction, is so far from receiving any additional Fluid from the Nerves, that its Quantity is very much diminish'd, while it is squeez'd out with an increased Impetus and Velocity, by the compressive Force of the contracting restoring Nerves.

BUT besides this, the common Doctrine concerning muscular Motion is plainly inconsistent with the Circulation of the Blood, and with all the known establish'd Laws of Nature in the animal Oeconomy: For 'tis here supposed, that the longitudinal Fibres, as they are call'd, which constitute the main Body of a Muscle, are divided at small Distances by transverse Fibres, as so many Ligatures, into innumerable little Cells, *Vesiculæ* or Bladders, communicating with the Blood-Vessels and Nerves; in which small Vesicles or Bladders, the Blood and nervous Fluid mixing, presently run into a Fermentation; and by their Rarefaction and Expansion, swelling and blowing up the little Vesicles, the Body of the Muscle is hereby inflated and distended, or increased in Thickness while it is shortned in Length. This is the common Hypothesis, at least so far as I am able to comprehend it, and which I take to be incumber'd with several insuperable Difficultys. For,

IN the first place, no such Fluid in the Nerves could ever be found, as being mix'd  
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with the Blood, would occasion any such Fermentation, Rarefaction, or Expansion, as is here suppos'd: and yet this is a Matter which certainly ought to have been well clear'd in fact, before it had been receiv'd as a Law of Nature, and made use of to account for other Phænomena; especially before so great a stress had been laid upon it, in accounting for almost all Diseases.

BUT supposing these muscular Cells, Vesicles, or little Bladders to be inflated, as is here imagin'd, by the expansive Force of an included Fluid; yet no such Effect could follow, as shortning the Muscle in Length and swelling it in Thickness: but the Consequence in this case must be, that the Muscle would be lengthned as well as thickned; that is, it must increase its Dimensions proportionally every way, which is the proper and natural Action of the Fluids upon the Solids, as has been shewn already.

P E R H A P S it may be said, that these Strings of Vesicles or little Bladders, when the Muscle is stretch'd or extended, are drawn into oblong Spheroids; but when they are inflated by the Mixture of the nervous Fluid with the Blood, they are reduced to a spherical Figure, by which means their Axes will be shortned, and their conjugate Diameters enlarg'd. But since the Vesicles must be allow'd to be soft, flexible, distractile, and equally yielding every way; and since an included expansive Fluid must press its containing Vessels equally every way,

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way, that is, in the Direction of its Axis and conjugate Diameter equally; 'tis manifest that any Vessel, notwithstanding such Pressure or Distension, must retain its natural or proper Figure; and being equally distended and stretch'd in all Directions alike, must proportionally be enlarg'd in all its Dimensions. But there is one thing farther which must entirely overthrow this Hypothesis, and that is, that no such Rarefaction or Expansion in the Muscles can possibly happen, without giving an invincible Check, or putting a stop to the Circulation of the Blood. For since the Blood circulates continually and freely thro' these muscular Vesicles, by the Hypothesis, 'tis evident that these Vesicles must be continu'd Canals with the Blood-Vessels; for otherwise there would be a continual Extravasation of Blood, which must soon put an end to the Circulation, and to the Life of the Animal. And since the Blood circulates freely thro' these muscular Cells or Vesicles, 'tis plain that as soon as ever they begin to inflate and blow up, the Blood must be immediately push'd forward with an increas'd Velocity in the Course of its Circulation; which must necessarily prevent any such Inflation, Tume-faction or Distension in the Muscles. Before these Vesicles therefore can be blown up and distended in the manner that is suppos'd, the Exit of the distending rarefying Fluid must be hinder'd; that is, the Circulation of the Blood must be stop't. And if any one should

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doubt of this, let him try whether he can blow up a Bladder or other Vessel that is open at both Ends, and where the expansive Fluid has as free an Egress as Ingress. But if this cannot be done, it must be equally impossible to inflate the Muscles according to the common Hypothesis, while there is an open free Communication with the Arterys and Veins.

THESE things premised, the natural mechanical Action of a Muscle will be now easily understood and explain'd: for 'tis evident from the Structure and Constitution of a Muscle, as already describ'd, that upon the Contraction of transverse and spiral Fibres, which are the Ramifications and Twinings of the Nerves, the longitudinal, red, and fleshy Fibres or Blood-Vessels, which constitute the main Body of the Muscle, must be squeez'd, contorted and drawn together, as being compell'd to follow the Motion and Direction of these contracting elastick nervous Cords; by which means the Blood-Vessels being straitned and compress'd, must be forc'd with some impetuosity thro' the Muscle, and propell'd forward in the Course of its Circulation. Now if the Blood should hereupon stop, and return no more to the Muscle, 'tis plain that the Muscle must for ever remain in this contracted State, as its proper and natural state of Quiescence to which it tends; and where it would rest, by the intrinsick elastick Power of these nervous contracting Fibres: But the Blood having receiv'd a fresh Impetus by the  
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Contraction, and returning upon the Muscle in the Course of its Circulation, rushes into the Blood-Vessels, which being enlarg'd in all their Dimensions by the Force and Impulse of the returning Blood, the transverse and spiral nervous Fibres must be hereby stretch'd, and the Muscle extended; by this means the Blood-Vessels being brought to their natural and due Extent and Capacity, and consequently the stretching distending Force of the Blood ceasing or diminishing, the contractive Power of the Nerves will in that state begin to act again, and restore themselves with the same Force by which they were stretch'd and extended; till the returning propell'd Blood re-enters the Muscle, and stretches it again, as before describ'd. Now 'tis evident that these two Counterforces being once thus adjusted and æquipois'd, this alternate Contraction and Extension must be continu'd necessarily and mechanically, without any Dependence upon Will or free Agency, till the Æquilibrium be broken, and the Motion some way or other preternaturally interrupted and suspended. And from hence appears very plainly, what has been observ'd before; that every Muscle of mere natural involuntary Motion, has its contracting and stretching Powers within itself, or in its own Structure and Constitution, without needing the aid and assistance of antagonist Muscles.

BUT where the Bones and Members are to be mov'd with any great Force in contrary

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Directions, by the command of the Will, the Author of Nature has every where in this Case provided the Animal Machine with antagonistical Muscles, one of which is contracted while the other is extended: and how the Matter stands in this case with respect to muscular Motion, or how this voluntary Motion differs from that which is natural and necessary, I shall now proceed to shew.

Now since the Muscles of necessary and voluntary Motion, have plainly the same internal Structure and Constitution, with respect to the Twinings and Ramifications of the Nerves with the Blood-Vessels; 'tis manifest they must have the same necessary mechanical Action: that is, they must be alternately stretch'd and extended, contracted and compress'd, in consequence of their Organization and Structure; whether there be suppos'd to be any Interposition of the Will, or Influence and Impression of the Mind upon them or not.

AND here with respect to this necessary and barely mechanical Action of the Muscles, those which are intended for voluntary Motion, and which are therefore provided with Antagonists, are stretch'd and extended, or contracted and compress'd, together and at the same time: by means of which conjunct and uniform Action of the same pair of Antagonists, these Muscles, so far as they act naturally, necessarily, and independent on the Will, are always kept in *Æquilibrio*, as being continually and alter-

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alternately impress'd with two contrary equal Forces.

BUT here the Author of Nature has put it into the Power, or under the Command of the Mind, by a Volition, Preference, Choice, or free Determination, to alter this *Æquilibrium*, and turn the Balance one way or the other at pleasure: that is, the Mind by willing, directing, or determining it, can impress the nervous elastick Cords, or *Fibrillæ* of any Muscle which has an Antagonist, with a certain Stimulus, Irritation, or compressive Energy, by which the Muscle so impress'd is brought into a strong and forcible Contraction, against the contrary much weaker, and merely mechanical Force of its antagonistick Muscle.

THIS is evidently so in fact, but the manner of it can no more be explain'd than the Union of Soul and Body, of which this is one of the Laws. 'Tis plain in fact, that external Objects, by striking and impressing the Organs of Sensation with a certain Stimulus or Irritation, excite their peculiar and appropriate Ideas in the Mind; and on the other hand, the Mind by willing, directing, and determining it, can impress the Nerves with stimulating, contracting, and compressive Force upon the Blood-Vessels, by which the antagonistick Muscles are drawn in their respective contrary Directions at pleasure. Now the best way of accounting for this, is, doubtless, to resolve it into the Will and Power, or conti-

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nual Prefence and Action of the first Cause, who has establish'd such a Law, and continues it in force and execution. They who do not like this, may by Imagination create as many intermediate Causes as they please; but they must either come at length to a first Cause, and so take all this Round to no purpose, or else run up the account of Matters *in Infinitum*, without ever coming to a first Cause; or, which is the same in the issue, suppose every thing to be Effect without Cause, or without any original independent active Power or Principle of Energy and Motion: which must reduce Religion and Philosophy to the same desperate State, and destroy all the Principles of Reason, as well as of Virtue and moral Conduct.

## COROLLARY.

FROM hence we may conclude the Insufficiency and Unusefulness of the several labour'd and learned Computations which have been given us of the muscular Force of the Heart, as if this was the only, or at least the chief Cause of the Circulation of the Blood.

FOR since these muscular elastick *Fibrillæ* are every where twin'd and interwoven with the Blood-Vessels, not only in the Muscles strictly so call'd, but also in the Glands, the muscular Coats, and universally wherever any Blood-Vessels are to be found: and since every such elastick Fibre, being stretch'd, must by  
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its Contraction compress the Blood-Vessels, and squeeze forward the Blood; 'tis evident that the whole Force by this means impress'd upon the Blood, must be the Sum of the Forces of all the elastick Fibres taken together, and consequently that the Heart in this Case can contribute but its share; and that with respect to other Muscles, in proportion to its strength: and therefore, to attribute the Circulation of the Blood to the sole Impulse and Protrusion of the Heart, must be extremely unphilosophical and immechanical, as being contrary to the plain and obvious Laws of Animal Motion.

BUT neither is this muscular Action of the elastick nervous *Fibrillæ*, and their Compression upon the Blood-Vessels, the sole Cause of the Circulation of the Blood; for we know that Liquors may freely circulate thro' exceedingly fine and almost infinitely small Tubes, without any muscular Force or Action at all; as is the case in Trees and Vegetables of all kinds, and likewise in the Passage of the proper Aliment and nutritious Liquors thro' the Bones and most solid Parts of Animal Bodys, where no muscular Action can be conceived; and which sort of Circulation or Passage of Liquors, must therefore be ascrib'd to that other Principle or Law of Motion, *i. e.* the corpuscular Attraction, as explain'd and demonstrated, *Prop. 34. Part I.*

## PROPOSITION V.

*THE Nerves are replenish'd with a soft oily Liquor, not much unlike the White of an Egg; serving to cool, moisten, and lubricate the nervous elastick Fibres.*

THAT the cortical Part of the Brain is glandulous, and contriv'd for the Secretion of a certain Liquor from the Blood, and that the Nerves take their original in numberless small Pipes or *Tubuli* from these Glands, is plain Matter of fact, and confirm'd by the concurrent Observation and Experience of all Anatomists: and that such a Liquor as here describ'd, is likewise actually found in the Nerves, and presently discharges itself when any Nerve is cut or wounded, is equally true and undeniable in fact.

THE first part of this *Proposition* therefore, with respect to the actual Existence of such an oily lubricating Fluid in the Nerves, being evident in fact, must be allow'd as a thing past all dispute. And as to the latter part of the *Proposition*, the Necessity of such a Fluid or Liquor to the Purpose here assign'd; it must be also equally plain and evident, to any one who will consider the Nature of such elastick springy Fibres, of which the internal Substance of the Nerves consists: for 'tis well known, that all such elastick Fibres require a due Degree of moistning, softning and lubrication, in order to retain their Flexibility and  
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capacity of Extension ; when they are overheated and dry'd, they contract immediately, and become so stiff and inflexible, as to be incapable of stretching by any ordinary Force.

SUCH stiffness, hardness, and inflexibility, is what always, in fact, happens to a Nerve, when this animal Oil, or softning lubricating Liquor, is by any means obstructed and intercepted ; the Nerve depriv'd of it immoderately contracts, hardens and dries up, so as to lose its proper and natural Action.

ON the other hand, where the Nerves are too much soak'd and drench'd with this oily lubricating Liquor, they presently grow soft, lax, and flabby, and will easily yield to any the least stretching Weight or Force, without any Capacity of contracting and restoring themselves. And these being the two most common and remarkable Diseases of the Nerves and elastick Fibres, arising either from the Excess or Defect of this animal Oil or nervous Fluid ; I presume the *Proposition*, from what has been here said, must be thought sufficiently confirm'd ; unless it be with those who from the Credit of a bare Hypothesis, without any Proof, have ascrib'd to this animal Oil or nervous Fluid, an Office, as they imagine, of much greater importance, under the Name of *Animal Spirits* ; while it has been thought to be the main Cause of muscular Motion, by mixing and rarefying with the Blood in the Muscles, thereby distending and widening them transversely, while they are contracted and shortened longitudinally. BUT

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BUT having already, as I think at least, establish'd a true Theory of muscular Motion, upon evident Facts, and shew'd the Falshood of this Hypothesis, as contrary to the Laws of Nature, and the Motion of the animal Fluids; I shall here spare myself the Trouble of any farther Confutation.

### PROPOSITION VI.

*THE Lungs are a Muscle; in which the Air performs the same Office with the Blood in other Muscles.*

THE *Trachea*, as is commonly known, having enter'd the Cavity of the Thorax, divides itself into two main Branches; each of which sends forth an infinity of smaller Branches and Ramifications, which are complicated and interwoven into innumerable *Vesiculæ* or little Bladders, all communicating with the common Trunk. Each Lobe of the Lungs is divided into a certain number of Lobules, and each Lobule into these extremely minute Vesicles. The Blood-Vessels being the Branches and Ramifications of the pulmonary Artery and Vein, are dispers'd and interwoven in a very curious and fine Net-work, with these bronchial Lobules and Vesicles; a Branch or Ramification of the pulmonary Artery, with its corresponding Vein, attending every Division and minutest Sub-division of the *Trachea*.

EACH Lobule consisting of the Branches and Ramifications of the *Trachea*, attended  
with

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with those of the pulmonary Artery and Vein, is wrapt up in a common Coat or Tegument; and the Lobes which they thus constitute, are likewise inclos'd and wrapt up in their common Coats or Coverings, by which they are fastned, compacted, and bound together.

FROM which Structure and Contrivance of this curious Organ, 'tis manifest that the Blood-Vessels must necessarily follow the Motion and Direction of the bronchial *Vesiculæ* or Air-Bladders, both which must be either extended and divaricated, or contracted and compress'd at the same time.

THUS when upon raising the Breast, the Air rushes in thro' the *Trachea*, and distends or blows up the *Vesiculæ* which communicate with the common Trunk; 'tis evident the Blood-Vessels to which these *Vesiculæ* are fasten'd, must at the same time be stretch'd, distended and divaricated: by which means, there will be an open and free Passage made for the Blood from the right Ventricle, to flow in, fill up, and distend all the Branches of the pulmonary Artery and Vein. But when the Thorax subsides, the cartilaginous annular Bandages of the Bronchia, the muscular Coats of the Lobules and Vesicles, together with the muscular Coats and Fibres of the Blood-Vessels, at the same time contract; whereby the Blood is forcibly propell'd and squeez'd out thro' the corresponding Branches and Ramifications of the pulmonary Vein, into the left Ventricle of the Heart; by the  
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Contraction of which, it is driven into the *Aorta*.

ALL this is obvious to the Sight, in a living Dog, whose Thorax has been laid open; where 'tis visible, that when the Lungs are blown up and distended with Air, the Blood-Vessels are at the same time stretch'd and divaricated, and the Blood rushing in thro' the Branches of the pulmonary Artery, the whole Substance of the Lungs becomes red, florid, and distended with Blood, while the Vesicles of the *Trachea* are distended with Air: but when the bronchial *Tubuli* and Vesicles contract, the Breast subsides; the whole Substance of the Lungs being compress'd, grow more compact, and the Blood is forcibly driven thro' the Branches of the *Vena pulmonaris*, into the left Ventricle of the Heart; and in short, every thing happens here after the same manner, as has been observ'd, in the Systole and Diastole of the Heart itself: from whence 'tis sufficiently evident, that the Lungs act as a Muscle; and that the Air in the small Tubes and Vesicles of the *Trachea*, performs the same Office with the Blood in other Muscles.

N o w so far as Respiration is purely mechanical and necessary, the Muscles employ'd in it, have their contracting and stretching Powers within themselves, so as to stand in need of no Antagonists: and after what manner the Quantity and Moment of the circulating Blood act as a Balance or Counterpoise

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to the contracting restoring Power of the Nerves, has been shewn already. But because this Act of Respiration is likewise partly voluntary, and the Muscles employ'd in it are evidently in some measure under the Command of the Will; it will be necessary to consider this Matter a little farther, and to shew what are the true and real antagonistick Powers in this voluntary Action.

THAT the intercostal Muscles and Diaphragm, by which the Ribs are rais'd, and the Cavity of the Thorax enlarg'd, have no proper Antagonists within the Body, is well known and commonly allow'd: and yet without some such antagonistick Power, the Act of Respiration must be purely mechanical and necessary, and could not be at all subject to the Command and Direction of the Will. Here therefore the Author of Nature, by an extraordinary Contrivance, has made the Lungs (thro' the Interposition and conjunct Action of the common Air or Atmosphere) the proper antagonistick Power to the intercostal Muscles and Diaphragm. And how this is brought about and effected, will be plain from what follows.

'TIS commonly known, that the external Air or Atmosphere presses upon the Surface of an animal Body, as well as upon the Surfaces of all other Bodys immerfed in it: and that this Weight or Pressure upon a given Surface, is equal to the Weight of a Column of Quicksilver, whose Base is the given Surface,

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face, and its Altitude 30 Inches. Now the Weight of a cubick Inch of Mercury is 8,102 Ounces *Avoirdupois*; and therefore the Weight of a Column of Mercury, whose Base is one square Inch, and its Altitude 30 Inches, is 243 Ounces. And if we suppose the whole Surface of the Body to contain 15 square Feet, or 2160 Inches, the Weight of Air pressing upon the Surface of such a Body will be 524680 Ounces, or 32780 Pounds Weight. The Thorax, which is rais'd and depress'd alternately in Respiration, may be consider'd as a Cylinder, whose Circumference is 40, and its Altitude 8 Inches; of which Cylinder, the convex Surface will be 320 Inches; and consequently the Pressure of the Air upon it, will be equal to 4860 Pound Weight.

IT must be observed here, that the reason why so great a Weight or Pressure upon the Surface of the Body has no sensible Effect, is this; that the internal Cavities of the Body, and the Interstices of the Blood and animal Fluids, being all fill'd with Air of the same Force and Spring with the external Air, while these two equal Forces in contrary Directions are kept in *Æquilibrio*, they will mutually support and balance each other; and every thing will remain in the same State either of Motion or Rest, as if there was no such Weight or Pressure at all: but when once the *Æquilibrio* is broken, and one of these Powers prevails over the other, the Effects will be very great and sensible, as we shall see farther on.

Now

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Now from hence it is evident, that the intercostal Muscles and Diaphragm cannot act so as to raise the Ribs and enlarge the Cavity of the Thorax, unless the external Air be at the same Instant of Time admitted into the Lungs, to fill up the internal enlarg'd Cavity of the Breast, and thereby support it against the Weight and Pressure of the external Air. For should we suppose the Ribs to be raised, and the Cavity of the Thorax enlarg'd, without the admission of the external Air; the external Surface of the Thorax must, as has been shewn in that case, sustain a Weight or Pressure equal to 4860 Pound: a Weight against which the elevated Ribs could not possibly be supported by the natural Power of the Muscles, without the instantaneous Immission of the Air into the Lungs, by which the internal Cavity being fill'd, the elevated Ribs will be supported and kept in *Æquilibrio*, against the contrary Weight and Pressure of the external Atmosphere.

AND for the same Reason that the Thorax cannot possibly be rais'd and supported without Inspiration, or the Immission of the external Air into the Lungs, it must necessarily subside, upon the Emission of the Air, in Expiration; since otherwise it must continue elevated and sustain'd, in opposition to a Weight against which it could not possibly be rais'd at first: which is equally impossible.

VOLUNTARY Respiration therefore is thus perform'd: When the intercostal Mus-

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cles and Diaphragm are strongly impress'd and contracted by the Power of the Will, the external Air rushes in to fill up the internal Cavity, and support the rising Breast against the Weight of the Atmosphere. On the other hand, when the muscular Coats and Fibres of the Lobes and Vesicles of the Lungs are forcibly contracted by the same Action of the Will, and the contain'd Air driven out, the Weight of the Atmosphere must again take place, and necessitate the Thorax to subside, to avoid a Weight or Pressure too powerful for the contractive Force of the Muscles, which had before rais'd and suspended the Thorax. From whence 'tis plain, that as the Air admitted into the Lungs is the means of sustaining the elevated Breast, against the otherwise insupportable Weight of the Atmosphere ; so the same Weight and Pressure of the external Air, necessitates the subsiding of the Thorax, upon the Contraction and Compression of the Lungs. And after this manner the Lungs, by the Intervention and conjunct Action of the Atmosphere, is the antagonistick Power to the intercostal Muscles and Diaphragm.

### S C H O L I U M I.

SINCE the Blood-Vessels, when the Muscles contract, are strongly compress'd, and the Blood forc'd out of them, as has been shewn ; a Difficulty may here arise, how it should come about, that upon any such Compression  
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the Blood is not driven equally both ways, or in two contrary Directions at the same time. Now to prevent this Effect, which must be inconsistent with animal Life, and soon put a stop to the Circulation of the Blood, the Author of Nature has in the first place provided the Veins, at certain small Intervals, with Valves, which open towards the right Ventricle of the Heart, to make way for the Passage of the Blood in its natural Course; but shut and close the contrary way, so as to prevent any reflux of the Blood back again upon the Arterys: and at the same time, the reflux of the Blood from the Arterys, is prevented by the strong Valves which shut up the Ori-  
the *Aorta*, and which opening to let the blood pass from the left Ventricle, do presently close again to hinder its return from the Arterys upon the Heart; by which means, when the Blood-Vessels in a Muscle are compress'd and constring'd by the contracting elastick nervous *Fibrillæ*, it must necessarily be driven forward in its natural Direction; that being the only way in which any impress'd Force can determine it.

BUT secondly, it must be observed farther, that all muscular Motion is propagated successively, according to the natural Direction of the Blood in the Course of its Circulation. For since the Blood-Vessels are stretch'd and distended by the Influx of the Blood from the Heart; if these Vessels are supposed to be divided into innumerable small transverse con-  
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tiguous Sections, 'tis evident that all the Sections thro'out the whole Length of a Vessel, will not be stretch'd and distended instantaneously and precisely at the same time; but successively, in consequence of the successive Motion and Propagation of the Blood. And since the muscular elastick Fibres contract in consequence of, and in proportion to the stretching distending Force of the Blood, 'tis plain that the Contraction must first begin where the Distension was first made; and be propagated successively after the same manner, and in the same Direction.

THIS successive Propagation of muscular Motion is very visible in the Heart, whose Auricles begin to contract first, and then the Ventricles at a very small but sensible interval, as the Blood is propell'd forward. And this successive propagation of Motion, will be more distinct and sensible as the Heart grows weak, and the Motion slow and languid: for then it may be plainly perceiv'd, that the Motion begins at the right Auricle, from whence it proceeds to the left, and from thence to the Ventricles; and the right Auricle will continue moving, or dilating and contracting for some time after the left Auricle and Ventricles are at perfect rest.

BUT this successive propagation of muscular Motion, is most visible and remarkable in the Intestines; where the alternate Dilatation and Contraction beginning at the Stomach, is continu'd by successive Undulations thro' the whole

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whole Length of the Guts ; by which means, their Contents are still press'd and squeez'd forward towards the *Anus* : but upon any violent and preternatural Inversion of this Motion, the Contents of the Intestines are all brought upward, and discharg'd at the Mouth. And after the same manner, the Blood must be driven back upon the Heart, and all the Valves and Flood-gates of the Machine broke to pieces, were it not for this natural Direction and successive Propagation of muscular Motion ; which mischief is hereby effectually prevented.

S C H O L I U M II.

ANOTHER Question may be rais'd upon this Subject, of which it may not be amiss to take some notice here ; and that is, How an elastick Fluid, such as the Air, should be any ways necessary to the Ends and Purposes of Breathing. For 'tis manifest, that any other Fluid, tho not at all elastick, in which our Bodys might have been immers'd, must upon the Elevation of the Thorax have rush'd into the bronchial *Vesiculæ*, so as to distend and fill them up : and upon the Contraction of these Vesicles, the Blood-Vessels of the Lungs must have been constring'd and compress'd, and the Blood driven forward after the same manner : and consequently, some other important use of the Air in Breathing must be allow'd, besides this alternate Dilatation and

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Compression of the Blood-Vessels, in the muscular Action of the Lungs.

NOW 'tis certain from *Prop. 35, 36. Part I.* that the Air join'd with elementary Fire, is absolutely necessary to keep up the Fluidity and natural Heat of the Blood; without which, it must immediately cool, condense, and become a fix'd solid Mass: and 'tis extremely probable, at least, that as the Air is thus absolutely necessary to these Purposes, so there is a necessity likewise of a continual supply of cool fresh Air, to be diffus'd thro' the whole Mass, while the Air before contain'd in it, being over-heated and rarefy'd, is perpetually flying off thro' the cutaneous Glands in Perspiration, and perhaps thro' all the other Excretory Ducts and Out-lets of the Body.

BUT there seems no way so proper and convenient for supplying the Blood with fresh Air, as from the Lungs, thro' which the whole Mass successively passes. From these bronchial *Vesiculæ*, the finer and more attenuated Parts of this elastick Fluid, by means of certain very minute transverse *Tubuli*, may be drawn off, convey'd into the Blood-Vessels, and mix'd with the Blood; while the grosser Element is driven out by the Contraction of the Vesicles, and the Blood squeez'd and propell'd forward by the muscular Action of the Lungs, as before explain'd.

A DUE Quantity and Proportion of this ætherial Fluid, is necessary to keep up the natural Heat and Fluxility of the sanguinary  
Mass:

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Mafs: but where it too much abounds, as being retain'd and pent up by the too great Viscidity of the Mafs, the heated rarefy'd Air not passing off as the fresh Air is deriv'd; the Blood, in this case, must become turgid and flatulent, run into preternatural Ferments, and over-stretch and distend the containing Vessels, especially in the Glands and Lymphaticks; the Consequences of which are very obvious. 'Tis very plain that the natural and due State of the Blood and animal Fluids, must depend very much upon the just Balance and *Æquipoise* of the external and internal Air: while this *Æquilibrium* is duly maintain'd, the animal Fluids are *cæteris paribus*, in a natural and good State; but this *Æquipoise* being broken, either by increasing the Viscidity of the Blood, and a too great Quantity of Air detain'd in it, or by lessening the Weight and Pressure of the Atmosphere, the Effects must be very sensible and considerable, especially upon Valetudinarians; and above all, such as are subject to the peculiar Diseases and Disorders of the Head and Stomach: for in such, the Cause here assign'd must be attended with preternatural Heats, asthmatick Breathings, hysterical Suffocations, Lethargys, Vertigo's, Apoplexys, Epilepsys, and all the Appearances and Symptoms of Over-fullness, Rarefaction, and Distension.

Now as these Diseases are some of the most grievous that can befall us, in which the stretching distending Force of the Blood over-

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powers the contractive reſtitutive Force of the muſcular nervous *Fibrillæ*, 'tis plain from hence how much it concerns the Phyſician, in all ſuch caſes, to reduce the Blood and animal Fluids to a due ſtate of Fluxility, and to relieve the over-ſtrain'd Veſſels by proper and timely Evacuations, that the motive Fibres may be at liberty to contract and recover their elaſtick Tone.

PROPOSITION VII.

*TO explain the Flux and Reflux of the vital Fluid, or the occasional Elevation and Depression of the Blood.*

'TIS well known, that the animal Conſtitution is ſubject to very conſiderable Alterations and Changes, with reſpect to the diffuſ'd Heat and Effluſus of the Blood, and the Life, Vigour, and Briskneſs of Thought and Motion. A Man ſometimes finds himſelf ſtrong, active and lively; his Pulse is raiſed, his natural Heat diffuſed, and he is every way diſpos'd for Thought and Motion: at another time the ſame Perſon is liſtleſs, languid and dull; his Pulse weakens, his natural Heat retires, and he is altogether unfit for any Action of the Body or Mind. This Reciprocation is commonly call'd the riſing and ſinking of the Spirits: and as this Viciffitude and interchangeable State of the Conſtitution falls under every one's Obſervation and Experience, ſo every body knows by what means the Spi-  
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rits are depress'd and sunk, and what the usual Methods are of raising them: but 'tis my business here only to explain the Mechanism of those different Phænomena or Appearances, and to shew from what Causes and by what Means they are induced and brought about.

FROM what has been shewn, *Prop. 4.* it must, I presume, be sufficiently evident, that all muscular Motion is perform'd by the intrinsic elastick Force of the nervous *Fibrillæ*, contracting and restoring themselves against the stretching distending Force or Impetus of the reflux Blood: and consequently, as long as these two Counter-Weights or Powers are kept in *Æquilibrio*, and their natural and due Balance maintain'd, the alternate Dilatation and Contraction of the muscular Organs will be regular, and the animal Constitution sound and healthy. But where these motive Powers rise too high or sink too low, or where the *Æquilibrium* is broken, by one of the Counter-Forces prevailing over the other, the Motion must become irregular and preternatural, that is, morbifick or diseased.

IF therefore the Dilatation of any muscular Organ be strengthened and increased, by the increased *Momentum* of the reflux Blood, the elastick motive *Fibrillæ* from the *Stimulus* of their stretch or bent, will contract themselves more forcibly to a certain Degree, proportional to the stretching distending Impetus of the Blood, by which the *Æquilibrium* of the two

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Counter-Forces will be still retain'd; but the Action of the Muscle, or its alternate Dilatation and Contraction, will be quicker, stronger, and more intense. And this Augmentation of muscular Motion, may be either in a just and due Proportion, so as to increase and perfect the animal Strength, Activity and Vigour, or in a preternatural and immoderate Degree, so as to become morbidick, and very pernicious to the Animal Constitution.

BUT where the Force and Impetus of the Blood shall be too strong for the contractive Power of the nervous elastick Fibres, the *Æquilibrium* will be broken, and the Action of the Muscle must become weak and languid, by a Diminution of the contractive Force, now overpower'd by the contrary stretching distending Force of the Blood; while on the other hand, where any such muscular Organ is depriv'd of its due Quantity and Proportion of Blood, the nervous elastick Filaments contracting by their own innate Energy, the muscular Action must weaken and languish, from the Diminution of the stretching distending Force of the Blood, now overpower'd by the compressive Force of the contracting Nerves upon the Blood-Vessels. Now after what manner muscular Motion, and all animal Force, Activity and Vigour, may be rais'd or depress'd by the Afflux and Reflux of the Blood to and from the Head and superior Parts, will appear from the following Phænomena, and the plain and obvious account of them.

P H Æ N O-

PHÆNOMENON I.

ALL Opiates, volatile Salts, inflammatory Spirits, heating fermented Liquors, volatile pungent Aromaticks, Camphire, Saffron, and in general all Substances which consist of very subtile attenuated Parts, and such as are dispos'd with a small degree of Heat, to rarefy and run into a Fermentation and *Flatus*; produce their Effects immediately upon the Stomach, by raising the Pulse, diffusing the Heat of the Blood, and increasing the Force and Vigour of animal Motion; and this before any Digestion, Chylification, or Conveyance of those Substances into the Blood, can be suppos'd or imagin'd.

EVERY body knows the immediate Effects of a Dram, or a Draught of any warming spirituous Liquor, in raising the Pulse, diffusing the natural Heat, and invigorating the animal Functions almost instantaneously, and as soon as ever they are taken into the Stomach. And that Opiates, volatile Salts, and Alexipharmicks, have the same immediate and, in a manner, instantaneous Effects, is plain from Experience, while the Substances themselves are still retain'd in the Stomach, and may be thrown out of it by vomiting, for a considerable time after their being taken in. From whence 'tis plain, that the immediate Action of those Substances is upon the Stomach.

## PHÆNOMENON II.

STRONG mineral Acids, such as the Spirit and Oil of Sulphur and Vitriol, fix'd Salts, raw acid Fruits, low thin unfermented Liquors, and in general every thing of a very cooling, constringing and condensing Nature, produce their Effects likewise immediately upon the Stomach, before Digestion or Chylification: in which case, the present sensible Effects of cooling, refrigerating, lowering the Pulse, recalling the natural Heat, &c. are directly contrary to those last-mention'd under the foregoing Head.

NOW in order to account for these different Phænomena, it may be observed, that the Stomach is a large concave Viscus or Bowel, seated in the Abdomen below the Diaphragm, which is capable of being blown up and rarefy'd to a considerable Degree, by the Heat and Rarefaction of any thing received into it; or, on the other hand, of being contracted, so as to bring the opposite Points of its muscular Coats into a Contact, by any thing admitted into it of a cold, condensing and stimulating Nature.

'TIS likewise Matter of fact, that the descending Trunk of the *Aorta* passes down behind the Stomach, and between that and the Spine, or back-part of the Ribs: from whence 'tis evident, that when the Stomach upon any occasion is inflated and distended, the descending Trunk of the *Aorta* must be compress'd

press'd or constring'd, between the Stomach and the Spine or *Costæ*; by which means, the Orifice or transverse Section of this Artery in its descending Branch, must be lessen'd, which must impede or resist the Descent of the Blood from the Heart, and oblige it to ascend in a greater Quantity and Proportion to the Head and superior Parts, where there is no such Resistance. By this means, the Head and all the Parts which are supply'd from the ascending Trunk of the *Aorta*, will be more stretch'd and distended with Blood, than the inferior Parts which are supply'd from the descending Trunk.

BESIDES this Ascent or Afflux of the Blood to the Head, occasion'd by the Distension and Inflation of the Stomach, and the consequent Compressure of the descending Trunk of the *Aorta*, there is another considerable Cause of the same Elevation, Tide, or Afflux of the Blood, from the same Inflation of the Stomach. 'Tis evident from the foregoing account of muscular Motion, that when the muscular Coats of the Stomach are thus stretch'd, inflated, and distended, the Blood-Vessels which enter into the Constitution of those Muscles, must at the same time be stretch'd, dilated, and remain full and turgid with Blood; which Blood cannot be driven forward in the Course of its Circulation with its natural and due Velocity, but by the Contraction of the muscular Coats of the Stomach, and the compressive Force of their nervous  
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elastick Fibres upon the Blood-Vessels: and therefore, so great a Quantity of Blood as must be retain'd and retarded in these Blood-Vessels, during this Distension and Inflation of the Stomach, must prove an Obstacle or Resistance to the Descent of the Blood from the Heart, and oblige the vital Tide to move upwards in the ascending Trunk of the *Aorta*, with an augmented Force and Impetus towards the Head, as before.

As this Distension and Inflation of the Stomach, from the Rarefaction, Heat, and Fermentation of its Contents, must accelerate the Velocity of the Blood in the ascending, and retard in the descending Trunk of the *Aorta*; so 'tis manifest that when this *Flutus* and Distension, and the consequent Resistance to the Descent of the Blood are taken off, the quite contrary Effects will follow: for the Blood now meeting with less Resistance downward, suddenly changes its Course, and its Velocity and *Momentum* must be augmented in a contrary Direction, by this Alternation and occasional Afflux and Reflux of the Blood; the Pulse is accordingly strengthen'd or weaken'd, the natural Heat raised and diffused, or recall'd and concentr'd; and the animal Functions in general are either quicken'd and invigorated, or infeebl'd and depress'd.

### S C H O L I U M.

FROM this Principle, the Nature of Sleep, the Effects of Opiates, spirituous Liquors and  
volatile

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volatile Salts; and the Origination and Cure of all soporiferous narcotick Diseases, are easily understood and explain'd: of which I shall here give some general Cases, including and comprehending all the rest.

1. WHEN the Heat and Rarefaction in the Stomach, and its consequent Distension, are moderate, such as may be occasion'd by the Heat of the Fire after Cold, an ordinary Meal, a Glass or two of Wine, a good warm Dram, &c. this turns the Blood upward with an accelerated Velocity, but in an easy, equable, and uniform Stream; and hereby the Pulse strengthens, and animal Life and Motion are quicken'd and invigorated, the vital Fluid glows thro' the Veins, the Blood-Vessels in the Brain are agreeably and gently distended, and the Nerves in their Origin at the Brain are put into a soft, easy, undulating Motion; and this, by taking off any uneasy or painful *Stimulus*, which might have been occasion'd by Watching, Labour, Passions, or too great Evacuations, strengthens and assists the Operations of Nature at the Spring-Head, and diffuses a warm invigorating Pleasure thro' the whole Frame.

2. IF this Afflux of the Blood or vital Tide to the Head be increased somewhat farther, so as pretty strongly to dilate and distend the Blood-Vessels in the Brain, and press upon those Nerves which are the Organs of Sensation; the Action of these Organs and Instruments of Sensation will be hereby weaken'd,  
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interrupted, or quite suspended; according to the degree and measure of their Compression, by the turgid distended Blood-Vessels: and this will induce a Heaviness, Drowsiness or Sleep.

3. WHEN this Drowsiness or Sleep becomes preternatural, from the aforesaid Afflux of the Blood, the Distension of the Blood-Vessels in the Brain, and the consequent Compression of the Organs of Sensation being too great and too long continued; the Consequence will be what we call a Lethargy.

4. IF this Afflux of the Blood be not so great as to produce a Lethargy, but yet is longer continu'd in a more moderate Degree; any such constant and too great Afflux of a too great Quantity of Blood to the Head, will separate a greater Quantity of Lymph or Serum than ordinary, in the choroidal, pineal, and pituitary Glands, whose Lymphatics or Aqueducts being hereby stretch'd, distended, and at last broken, produces a Dropsy of the Brain, which is the most general and genuine Cause of a Palsy.

5. IF the Blood by this means be thrown with a strong, sudden, and violent Torrent to the Head, so as to break the Blood-Vessels, or stretch and distend them beyond the restitutive contractive Power of the Nerves, the Consequence is an Apoplexy.

6. IF this Cause be somewhat remitted, and does not prove directly mortal and destructive

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tive to the animal Nature, it often terminates in a confirm'd habitual Epilepsy.

7. THIS Afflux or Tide of the Blood being still brought a little lower, so as not to take away all Sense and Motion, but only to bear up the Diaphragm and Lungs, and hinder the Immiffion of the Air in a due quantity; especially when attended with the like Inflation and Distension of the Womb in Women, will produce all the Species and Symptoms of strangulating convulsive Fits and hysterical Suffocations.

THIS general morbidick Constitution, proceeding from the various Modifications of the vital Tide, or Afflux of the Blood to the Head, will be much strengthen'd, and the Disposition towards it increased, by any organical Disorder in the Brain; either from the wrong Conformation of its Vessels, or from some large, hard, and indissoluble Tumor of any of its foremention'd Glands.

THE same morbidick Constitution is likewise generated, confirm'd, and strengthen'd by the Weakness, Relaxation and Flaccidity of the muscular Coats of the Stomach, and the foulness of its Glands, stuff'd with a viscid tenacious Lymph or Slime. For in the first place, the Nerves and Blood-Vessels in the Brain being compress'd and too closely pent up, any small Quantity of Blood more than usual passing upward, must have the greater and more sensible Effects, for want of sufficient Room and Capacity of Distension in the compress'd

press'd streighten'd Blood-Vessels: and from the weakness of the muscular Coats of the Stomach, any Heat, Rarefaction, and Flatus of its Contents must the more forcibly distend and blow it up, while the elastick restitutive Force of its muscular Springs is not sufficient to resist the Rarefaction of the included overheated and expansive Air: and the Glands being stuff'd and loaded with a viscid Serum or Slime, retaining a great Quantity of Air, and mixing with the Meat and Drinks in the Stomach, will very much contribute to increase and strengthen the aforesaid Rarefaction, Flatus and Distension.

FROM this general account of Causes, the chief Intentions in the Cure are plainly these.

1. To make a speedy and effectual Derivation and Revulsion of the Blood and Humours from the Head.

2. To cleanse and scour the Glands and secretory Ducts of the Stomach, by proper Emetics repeated as occasion serves.

3. To keep up an easy, free and open Secretion by Stool.

4. To cleanse and open the small Blood-Vessels, Glands, and Lymphaticks of the Brain from any Dregs and Recrements, to make way for the free Circulation of the Blood and Lymph: and this will be best done by mercurial Deobstruents; of which the Cinnabar of Antimony, Æthiops Mineral, and the Antihectic of *Poterius* are principally to be regarded, join'd especially with black Hellebore.

5. To

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5. To strengthen the muscular Force and Action of the Stomach by proper Corroboratives, of which the Peruvian Bark is the chief, and stands beyond all competition against every thing else, in confirming a good Digestion, and preventing the Returns of any of these capital periodical Diseases. But the more distinct Consideration of what may be farther necessary to answer the chief Intentions of Cure, in this and the several other principal morbifick Constitutions, I shall refer to the third and last Part, where it will fall more directly and properly under my intended Design.

### PROPOSITION VIII.

*TO explain the Nature and Use of animal Secretion.*

THE Arterys in their last evanescent Branches, or small Divisions, before they are incurvated into their returning Veins, send out innumerable very minute hairy *Tubuli*, thro' which certain Portions of the Serum are drawn off from the Blood, while the Remainder passes on thro' the Extremitys of the Arterys, and returns by the Veins: and these exceeding fine Pipes or *Tubuli*, by which the Serum is partly drawn off from the Blood, before it passes the small capillary Arterys, are call'd the glandular Strainers, or secretory Ducts.

THE last Branches and small Divisions of any Artery, together with their glandular se-  
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cretory Ducts, their correspondent Twinings, and Ramifications of the Nerves and their returning Veins, being convoluted and wound up together, and included within a common Tunicle or Tegument, constitute a small roundish hard and fleshy Substance, which is call'd a Gland; and for distinction-sake, a conglobate or simple Gland.

ANY Number or Congeries of these conglobate or simple Glands, being fasten'd together by small transverse Fibres, and included again within a common Coat or containing Membrane, is call'd a conglomerate or compound Gland.

THESE secretory Ducts or glandular Strainers, which spring immediately from the last Branches and Divisions of the Arterys, uniting in the Glands, are sent out in larger Pipes or Canals, for the Propagation and Distribution of their secreted Liquors, in order to answer the several Ends and Purposes of these glandular Secretions in the animal Oeconomy; and of which Glands with respect to their general Uses, there are two very different and remarkable sorts: for either they convey their secreted Liquors thro' their proper secretory Ducts to be cast out of the Body, to free the Blood from the superfluity of Serum, which is still growing and accumulating from what we eat and drink; or else they deposite their Secretion in proper Receptacles, and distribute them thro' certain Pipes to be empty'd again into the Blood, under the common

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Name of *Lymph*: by which means, there is made a continual Drain of Serum from the Blood in the Arterys, which being distributed or circulated thro' a certain Course in the Lymphaticks, is return'd again upon the same Blood in the Veins. The first of these I call by way of Distinction, the *expurgatory*, and the other the *circulatory* or *lymphatick* GLANDS. Both these sorts of Glands are in number indefinite, and dispers'd over all the fleshy Parts of the Body: but the expurgatory Glands are for the most part of the compound or conglomerate Kind; whereas the circulatory, or those Glands which serve to secrete the circulating Lymph, are generally simple or conglobate: of these lymphatick Glands, an Infinity are to be found in the Intestines, the Mesentery, the Omentum, the Spleen, the Liver, and all the Parts of the Abdomen, which convey their secreted Lymph into the common Receptacle of the Chyle, and from thence together with the Chyle, it is empty'd into the Blood by the axillary Veins; and indeed the Lacteals, which receive the Chyle from the Stomach and Intestines, and convey it to the Blood, are truly and properly Lymphaticks, and perpetually flow with Lymph derived from these Glands, and which is incessantly draining off from the Arterys: by which means, all the chyliferous Ducts from the Intestines to the subclavian Veins, are continually fill'd with this circulating Lymph, whether they have any Chyle in them or not.

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And besides these lymphatick Glands arising from the several Parts contain'd in the Abdomen, which convey their Lymph to the Blood thro' the common Receptacle of the Chyle, there are innumerable others of the same kind in almost every other Part of the Body, which drain the Lymph from the Arterys, and communicate with the Veins by nearer and shorter Passages, without distributing their Serum to the common Receptacle and chyliferous Ducts; many of which have been observ'd and describ'd by Anatomists, and numberless others are doubtless too small and fine for any Observation or Description.

Now the Intentions of Nature in the general Structure and Constitution of the Glands, are manifestly these two.

I. THE Blood being discharged out of the large Vessels, and thrown into the numerous small Branches and Divisions of the evanescent Arterys, has its Velocity and Impetus exceedingly abated, by *Prop. 3.* of this Part. And the Velocity and Impetus of the Blood abating, the Heat and Rarefaction of the expansive Elements must be diminish'd, and the corpuscular Attraction of the Blood-Globules increas'd in the same Proportion, by *Prop. 37. Part I.* from whence by *Prop. 38.* there will be a more perfect Separation of the globular Part of the Blood from the Serum, and way made for the Serum to disengage itself, and shed off from the *Crassamentum*: and therefore, all the fine glandular secretory Ducts are  
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sent out from the Arterys in these their ultimate Branchings and Divisions, where the corpuscular Attraction being greatest, and the heating rarefying Force of the expansive Elements least, such a Separation of the Serum from the globular Part can only be made; whereas, had these glandular secretory Ducts been sent out from the larger Vessels, where the Velocity and expansive Force of the Blood is very great, and where consequently the Serum is intimately mix'd with, and strongly retain'd by the *Crassamentum*, nothing could have been separated or secreted but Blood, or the mix'd Mass without Alteration.

By means of these minute *Tubuli*, such as are the evanescent capillary Arterys, and the secretory Ducts of the Glands, a very slow and imperfect Circulation might have been obtain'd without any thing of muscular Motion, as is the case in Trees and Vegetables of all sorts; for in these the Sap rises from the Root, thro' an infinity of exceeding minute Pipes or small Tubes, by the corpuscular Attraction of the minute Parts; as explain'd *Prop. 35. Part I.*

BUT a quicker and stronger Circulation was absolutely necessary to Animal Life, and in order to keep up the natural Heat, Efflatus, and due Fluidity of such an oily, mucilaginous, and concrescible Liquor as the Blood. And therefore,

2. THE infinitely wise Author and Former of Nature has contriv'd and provided a proper Expedient to this Purpose, in the Structure and

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Constitution of the Glands ; which are manifestly constructed and adjusted to obtain the greatest possible Benefit and Advantage of muscular Force and Action.

'Tis commonly known, that the Arterys in all their minute Divisions and Subdivisions, are not only provided with muscular Coats, but likewise attended with their correspondent small Twinings and Ramifications of the Nerves. Now had the ultimate minute Branches of the Arterys been suffer'd to run out into single small hairy Twigs and Sproutings, the muscular Force in these single small *Tubuli* must have been very weak ; and consequently the Circulation thro' them exceeding slow, like that of the Sap in Vegetables ; which could not have answer'd the necessary Ends of Animal Life and Motion : to prevent which, these ultimate minute Branches of the Blood-Vessels, with their correspondent Twinings and elastick Filaments of the Nerves, and small secretory Ducts or glandular Strainers, are closely compacted, wound up together, and included within their common muscular Coats. From which Contrivance, the Glands thus form'd and constructed, must acquire and exert a very considerable muscular Force: for while the numerous nervous elastick *Fibrille*, the muscular Coats of the small Arterys, and the common muscular Teguments of the Glands themselves act conjunctly with their united Forces, and within a small Compass ; the Blood must be hereby squeez'd out of these

evanescent Arterys into the Veins, and the Lymph or Serum will at the same time be compress'd and squeez'd out of the numberless small secretory Ducts which spring from the Arterys, and driven forward into the larger Lymphaticks and Aqueducts which pass out of those Glands, and propagate or distribute their proper Liquors to their several and respective Receptacles, Emunctorys, and excretory Ducts, to serve the various Ends and Purposes of Animal Life and Motion.

THIS muscular Action of the Glands is evident, not only from their Structure, with respect to the Disposition of the Nerves and Blood-Vessels, which is the same here as in the Heart, the Diaphragm, and all other Muscles of mere natural Motion ; but is likewise obvious enough to Sight, in all the larger and more compound Glands, especially in the Stomach and Intestines, which constitute a true and proper Gland, the largest and most remarkable in the whole Body ; of which large and complicated Gland, the *Lacteals* are the secretory Ducts, and the *Anus* the common Emunctory or excretory Duct, thro' which the grosser, superfluous, and useless Part of what is digested in the Stomach is thrown out. And tho' this first, principal, and most noble Gland, differs in some Circumstances from the other simple and compound Glands already described, yet with respect to its main and essential Organization, Structure and Use, as a Gland con-

trived and design'd for Secretion, it is the very same. And,

THO these Glands have taken their general Name from their Figure, and most obvious sensible Qualitys, as small, hard, crisp, spongy, whitish, and roundish Bodys or Kernels, such as the conglobate Glands commonly are, of which the conglomerate are compos'd; yet if one might be allow'd to denominate them from their real Structure and principal Use, they might very properly be call'd the secretory Muscles; since their Action is plainly muscular, and absolutely necessary to squeeze and drive forward the Blood and animal Secretions thro' the capillary Arterys, and fine glandular secretory Ducts respectively; as much as the Motion of the Heart itself, which is allow'd to be a Muscle, or as any of those other Muscles commonly so reckon'd, which serve to move the Parts, according to their different Directions.

AND indeed, nothing could have hinder'd these Glands from being rank'd under this Class, as a particular sort of Muscles, but that their Action in their alternate Dilatation and Compression, is less sensible, and their real internal Structure and Constitution have not been so well understood or adverted to.

HAVING premised thus much concerning the general Structure, Conformation, and Use of the Glands, we may now the more easily and intelligibly explain the Reason of those different Secretions, and their more particular and appropriated Uses.

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'TIS plain in fact, that the expurgatory Glands especially secrete Liquors of different sorts, with respect to their different Degrees of Fluidity and Viscidity, Tenuity and Craftitude, and as they are differently stock'd and replenish'd with Oil, Sulphurs, volatile and fix'd Salts, and various sorts of Earths, as Chalk, Sand, Clay, Gravel, &c.

AND because all Fluids press equally *undiquaque*, 'tis likewise certain, that all the Vessels and organical Parts thro' which the Fluids are continually passing, must be Cylindrical or Conical; that is, their transverse Sections must be Circular: this being the necessary Consequence of the equal uniform Pressure of their circulating Fluids, which press, dilate and distend them alike in all Directions: And consequently all the different Secretions, as just now mention'd, must depend on these three things.

1. ON the different Diameters or Orifices of the secretory Ducts, or glandular straining *Tubuli*.

2. THE different Velocity of the Blood at the several secretory Ducts, as the Arterys are more or less complicated and divided before the Secretion is made. And,

3. ON the different Serosity of the Blood when brought to the secreting Gland, as it has been more or less drain'd of its Serum before its arrival.

As to the first, 'tis plain that all the secretory Ducts will admit any Particles that are  
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small enough to pass thro' them ; that is, any Particles whose Diameters are not larger than the Diameters of those secretory Ducts themselves : and consequently the pure Serum, Lymph, or fluid Part of the Blood may be secreted any where, as being capable of such Attenuation and Division of its Parts, as to enter the smallest and most minute Passages that can be conceiv'd or imagin'd ; while all the solid Corpuscles and larger Particles endu'd with a stronger Cohesion, whose Parts cannot be so intimately separated, divided and attenuated, must be kept back, and deny'd an entrance thro' those finer and most minute *Tubuli*. But as the Diameters of these glandular secretory Ducts are enlarg'd, they will be capable of admitting Corpuscles of a closer and stronger Cohesion, and that in a greater or less Proportion, as the Orifices of the secreting Tubes are enlarg'd : which different proportional Mixture of Salts, Sulphurs, Earths, &c. with the Serum, will constitute secreted Liquors of different Kinds, or different sensible Qualities ; according to the different Nature and Quantity of such cohering Corpuscles, with which the separated Serum is thus blended and replenish'd.

THE Secretions will likewise differ, on the account of the different Velocity of the Blood at the Orifices of the secretory Ducts : for since the Velocity and Impetus of the Blood is the Force by which all the muscular Organs are stretch'd and dilated ; and since the ner-  
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vous elastick *Fibrillæ*, within their natural and due Bounds of Tension, contract and restore themselves in proportion to the Force by which they are stretch'd and dilated, 'tis plain that the muscular Force and Action of a Gland, will be proportional to this Velocity and *Momentum* of the Blood; and the Quantity secreted in a given time, or the Velocity of the Secretion must be in the same Proportion: but the quicker any Secretion is made, or the faster the Serum is drawn off from the Blood, the thinner and more limpid or fluxile it will always be; whereas, when it drains off but slowly, and continues long in the Glands and secretory Ducts, it contracts a greater Viscidity, and becomes more tenacious and mucilaginous. This is evident in all the Secretions which are more thin and fluid in proportion to the Quickness of their Drain, or the Quantity discharg'd in a given time. But where any Matter is forced off which has continu'd long in the Glands, or stagnated in the Lymphaticks and Aqueducts, it is always thick, viscid and slimy, as having been turn'd into a sort of Gelly or Lenton, by the natural Heat under a small degree of Motion: and from hence it must follow, that those Secretions which are drawn off from the most Glands, or the most complicated Arterys, and after the greatest number of Divisions, are the most viscid; and those which are drawn off from the least complicated Arterys, after the fewest Divisions, are, *cæteris paribus*, the thinnest and most fluid.

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BUT lastly, the Secretions differ also on account of the greater or less Serosity of the Blood, when brought to the secretory Ducts of any particular Gland, as having been more or less drain'd of its Serum before in other Glands. Of this we have a very famous and pregnant Instance, in the wonderful Apparatus and Conduct of Nature for the Secretion of the Bile in the Liver; and this being not only a curious but a useful Speculation, in which others who have gone before me have not been very successful, I shall here consider it the more distinctly.

'TIS well known, that the Method which Nature has taken for supplying the Liver with Blood, is very extraordinary; for this famous Organ, contrary to all others, receives the Blood from which its proper Secretion is made, not from the Arterys, but from the Veins.

HERE therefore, the Blood which had been communicated by the Arterys, and dispers'd thro' the Intestines, Mesentery, Caul, Spleen, Pancreas, Stomach and Gall-bladder, returns by the correspondent Veins, which uniting in one large Trunk call'd the *Vena Porta*, the Blood is hereby after this wide and round-about Course brought to the Liver, and diffus'd thro' its whole Substance by the numberless Branches and minute Subdivisions of the *Porta*: this Vein therefore, with respect to the Liver, performs the Office of an Artery; and the Bile is here drawn off from the

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the Blood by small secretory Ducts or straining *Tubuli*, sent out from the minute Branches and ultimate Divisions of the *Vena Porta*, after the same manner that the rest of the Secretions are drain'd from the Arterys in all the other Glands.

Now to understand the Reason and Necessity of this peculiar and extraordinary Contrivance, it must be observ'd in the first place, that all Parts and Organs in the Abdomen, thro' which the Blood passes before it comes to the Liver, are abundantly stock'd, replenish'd, and every where disseminated with Glands; thro' which a very great Part of the Lymph or Serum must be drawn off, before the Blood returns in the Veins, which unite in the *Porta*, and convey it to the Liver. And indeed, whoever considers the large and winding Course thro' which these Arterys are dispers'd in the Abdomen, and the Infinity of lymphatick Glands with which those Parts abound, will hardly be able to doubt but that the Blood, from the continual drain of these Glands, must be depriv'd in a manner of all its Lymph or thinner part of its Serum before it enters the *Porta*: and 'tis evidently the Design of this large antecedent Drain of the Lymph, to prepare and dispose the Blood for the Secretion and Discharge of the Bile in the Liver.

THIS will be farther confirm'd if we consider the Nature and Use of the *Spleen*, and what is there manifestly done to the same  
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Purpose, and with the same Design as already mention'd.

THE Spleen is a large, soft and spongy Bowel, situated in the left Hypochondrium, between the Stomach and the Bastard Ribs; it consists of a very curious Contexture, Complication, and Congeries of Blood-Vessels, Nerves and Lympheducts. In this Bowel, the Blood-Vessels, Nerves, and lymphatick Strainers, are in their several Branches and Subdivisions convoluted and wound up into little Bundles, and included or bound about with their common and respective Coats or Coverings; a Congeries of which tied together by innumerable small transverse Fibres and Ligaments, constitutes the main Substance and complicated Organization of the Spleen. These vascular Convolutions and little complicated Bunches or Bundles of Blood-Vessels, Nerves and Lymphaticks, are so very soft, yielding, and spongy, by reason of the largeness of the Vessels, and the great Proportion of Fluids contain'd in them, that Anatomists have doubted, and still dispute whether they ought to be call'd Glands or no: but since they evidently perform the Office of Glands, and since a great number of Lymphaticks and Aqueducts arise from them, and convey their secreted Lymph or Serum, as well the grosser as the more thin and limpid Parts of it, to the *Receptaculum Chyli*; Men may call them what they please, for I am not at all concern'd about the Name, but only for the Nature and Use of them.

'Tis

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'TIS well known, that the splenick Artery is very large, and imports a greater Quantity and Proportion of Blood to this Bowel, than is usually allow'd to other Organs of the same bulk and size: 'tis plain also from the soft, spongy, and open Texture of the Spleen, that the ultimate Branches and Divisions of the splenick Artery and Vein, with their correspondent Lymphaticks, are larger than in other glandulous Organs, and contain a greater Quantity and Proportion of their respective contain'd Fluids: from whence it follows, that the Secretion here made must be proportionally greater, and that a larger Quantity of Lymph or Serum, as well the grosser as finer Parts of it, is drawn off and discharg'd in the Spleen, than in other glandular Organs of the same Dimensions; and for this Reason, the ultimate Branches and Divisions of the splenick Artery and Vein, are more distended and enlarg'd than in other Glands: that the Velocity of the Blood being hereby diminish'd, and consequently the Blood making a longer stay in the Organ, the Secretion might be the greater, and the Blood be the more perfectly purg'd and drain'd of its Lymph, before it enters the *Porta* by the splenick Vein, and passes to the Liver. And by this means, tho the Spleen is but a small Bowel, and contain'd within a narrow compass, in proportion to the larger and more numerous Organs contain'd in the Abdomen; yet the Blood which passes from the Spleen to the Liver, is  
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as much drain'd and depurated of its Serum, as that which is sent off from the Mesentery, the Intestines, Pancreas, Stomach, &c.

BUT farther, 'tis very remarkable to the same Purpose, that because the hepatick Artery is detach'd directly to the Liver, before it arrives at any other Glands, and consequently carries with it its whole Share and Proportion of Serum from the *Aorta*; therefore Nature has provided the Liver itself, at its Entrance, with an Infinity of small lymphatick Glands, by which the Serum in the hepatick Artery is drain'd off, before it penetrates and disperses thro' the Substance of the Liver, and joins the Branches and minute Ramifications of the *Vena Porta* at the biliary Ducts. And thus we see what wonderful Art and Contrivance the Author of Nature has discover'd, in deriving off the first Drains and Sublimations of Lymph or Serum from the Blood, by passing it thro' innumerable other Glands and Strainers, in order to prepare and dispose it for the Secretion of the Bile in the Liver; the Reason and Necessity of which, to the Purpose of such a Secretion as the Bile, must be next inquir'd into.

'TIS certain in fact, that the common Lymph or Serum of the Blood, such as passes off most easily and universally in the Glands, contains but little Oil, Sulphur, and volatile Salt, but abounds more with fix'd Salts and Earths of different sorts, as is plainly prov'd from the Distillation of the Serum, and well known

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known to the Chymists. This Part of the Serum therefore, is a very small, cooling, and diluting Liquor: but that Part of the Serum which coheres more strongly and intimately with the Globules, and which cannot be separated till after the other is drawn off, is strongly tinctur'd and plentifully saturated with Oil and volatile Salts, as Experience testifies: which volatile oily Quality in this last drain of Serum from the Blood, readily discovers itself both to the Smell and Taste, and may be confirm'd by any other proper Proof or Test to which it is brought.

FROM hence therefore the Reason of the foregoing Apparatus and Contrivance for the Separation of the Bile, is very plain and obvious: for since a Liquor was here to be separated, plentifully stock'd with the strongest Oil and volatile Salts of the Blood; and since this Part of the Serum has the strongest and most intimate Union and Cohesion with the *Crassamentum* or Blood-Globules, this strong, hot, and volatile oily Serum cannot be separated from the Blood, till the colder, weaker, and more fluid Parts, or the common circulating Serum, be first drawn off and discharged: and therefore it was necessary to make such a Drain of the common Serum from the Blood by the other Glands, according to the Method of Nature already consider'd and explain'd, before the Bile in the Liver could be separated and drawn off; which is such a curious and entertaining piece of natural Chymistry,

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mistry, as cannot but affect any one who considers it, with Wonder and Pleasure.

FROM hence the Reason is plain, why so great Quantity of Blood is pass'd thro' the Liver, for so small a Secretion as is that of the Bile: for since this part of the Serum which abounds with this sort of Oil and Salt, has the closest and most intimate Cohesion with the *Craffamentum* or Globules, a great Quantity of Blood must pass, in order to draw off but a very small Quantity and Proportion of this Liquor; and which could never have been secreted at all in any of the glandular Pipes, had not the lighter and less cohering Parts of the Serum been first drawn off, as has been shewn.

THIS then is the Wisdom and Providence of Nature, in drawing off a Liquor from the Blood, of all others, under so small a Quantity, the most necessary and important to animal Life. For this bilious Secretion is a potent Dissolvent, a wonderful Precipitant, and a most congenial and benign Cathartick: In short, this Liquor is the great refiner and purifier of the Chyle, the cleanser of the Bowels, and the strengthner and preserver of the Stomach in its Office of Digestion: and where this Secretion is either not made in the Liver, or not brought to and mix'd with the Chyle in its natural and due Quantity and Proportion, all the animal Liquors are presently dispos'd to Corruption, Putrefaction, and Stagnation.

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THERE remains one thing yet farther, of great Consequence to be consider'd and explain'd with respect to these glandular Secretions; and that is, the Nature and Use of the Lymph, or the Reason of that large and continual Drain of Serum from the Arterys, which is incessantly returned, and poured in again upon the Blood in the Veins. This is a Phænomenon which 'tis impossible to overlook in the Animal Oeconomy; and all the Anatomists accordingly take notice of it: but yet so little has been said about it as to the Reason and Necessity of it, that one would think it as impossible to be accounted for, as it is not to be taken notice of and observ'd.

BUT to shew the true Use and Design of this lymphatick Circulation, let it be here remember'd, what has been proved at *Prop. 1.* that the main Heat, Fervor, Efflatus, and Activity of the Blood, are retain'd and reside in the Globules; and next to these, that Part of the Serum which has the strictest Union and closest Cohesion with the *Crassamentum*, has the greatest Heat and Fervor, as being plentifully saturated with volatile oily Salts, and consisting of very subtile and active Parts, deriv'd from the Globules themselves.

BUT the other common circulating Serum, which freely and universally passes the Glands, is much smaller, weaker and thinner, and is plainly a cooling diluting Liquor, otherwise than as it is continually in some degree heated

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from the Globules, and their active volatile oily Salts.

THIS Serum therefore, to prevent its being over-heated and coagulated in the Arterys, is continually drain'd off thro' the lymphatick Glands; and having been for some time drawn off and separated from the Globules and hotter Serum, carry'd a round-about Course in the Lymphaticks with a slower Motion; and being thereby very much cool'd and condens'd, it is return'd upon the same Mass in the Veins to cool and dilute the Blood: by which means, the natural Heat of the Blood is abated, suppress'd, and kept within due Bounds. Which natural Heat proceeding from the Globules and active Oils and Salts, would be otherwise still increasing, and soon become unsufferable, and inconsistent with the Animal Life.

THIS I take to be the true Intention of the circulating Lymph, to draw off the over-heated Serum from the Arterys, and cool it in the Lymphaticks; to the end, that being continually returned fresh and cool, it may serve to temper and qualify the natural Feror of the Blood, and retain it within its due and proper measure. And that this is really so in fact, will be farther evident, if we consider how the case stands in Fevers, where the Secretions are stopt, and this drain of the Lymph for a time suspended and interrupted. For by the Heat and Rarefaction of the Blood in Fevers, the Blood-Globules are enlarg'd, and

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and imbibe and retain a great Part of the Serum, while the rest of the Serum thickens with the Heat, and strongly adheres to the *Craffamentum*: In which case, all the Secretions, and particularly that of the Lymph or Serum, must necessarily be diminish'd; in proportion to which Diminution, we find the Heat of the Blood always increases, till by proper Methods of cooling, diluting and condensation, the Lymph or Serum is prepar'd and dispos'd to separate and run off from the *Craffamentum*; and then the lymphatick Secretion and Circulation again taking place, there ensues a Solution of the Fever; and the morbid Heat being qualify'd, suppress'd and restrain'd, the Blood returns to its natural Constitution and Temper.

### PROPOSITION IX.

*THE continual Passage of the Blood thro' the small capillary Arterys, and of the Serum thro' the minute glandular Tubuli, is the great Principle of Attenuation in the Animal Oeconomy; by which the Blood and animal Fluids have their Parts most minutely broken, separated, and kept from coagulating, or running into large con-creted Masses.*

How exceedingly the Blood and animal Liquors must be divided and attenuated by a continual and repeated Draining thro' the small capillary Arterys and glandular *Tubuli*, will appear from the following Computation.

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The Diameter of a common Drop of Water is about  $\frac{1}{8}$  of an Inch, and the mean Diameter of a Blood-Globule as it swims freely in the Serum, I have found by Observation to be  $\frac{1}{300}$  of an Hair's Breadth ; 300 of which Breadths make an Inch : and consequently the Diameter of such a Blood-Globule will be only  $\frac{1}{300}$  of an Inch ; and the Magnitude of the Drop will be to the Magnitude of the Blood-Globule, as the Cube of  $\frac{1}{8}$  to the Cube of  $\frac{1}{300}$  ; or as the Cube of 600 to 1 : that is, as 216000000 to 1. But many of the Blood-Globules are much less, so as not to exceed  $\frac{1}{400}$  of such an Hair's Breadth ; of which Globules therefore there must go 1000000000 to make up the bulk of a common small Drop.

BUT 'tis certain, that the largest of the glandular secretory Ducts must be smaller than the least of the capillary Arterys ; because the least of the evanescent Arterys is capable of admitting the Blood-Globules, which the largest of the glandular Tubes cannot in their natural State, or without such Violence ; the Consequence of which must be bloody Secretions.

FROM hence therefore 'tis plain, the Blood and animal Fluids must pass those numberless exceedingly minute Tubes thro' which they are continually drain'd, in Particles as fine and subtile as any Steam or Vapour can be imagin'd : and while their Parts are thus separated and divided by the corpuscular attractive Powers of these minute *Tubuli*, 'tis Attraction

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traction and Colature is the great and universal Principle of Attenuation in the Animal Oeconomy ; by which the Parts of the Blood and animal Fluids are separated, comminuted, and kept from coagulating, or running into large concreted and cohering Masses.

### PROPOSITION X.

*THE expurgatory Secretions are augmented by Watching and Exercise, and diminish'd by Sleep and Rest : but on the contrary, the lymphatick Secretions are increased by Sleep and Rest, and lessen'd by Watching and Exercise.*

THE Truth of this *Proposition* will sufficiently appear from the following Observations and Phænomena.

THE most considerable of the expurgatory Secretions, and to which all the rest bear but a small Proportion, are those which pass off by Perspiration and Urine. Now 'tis evident in fact, from all the Experience and Observations we are furnish'd with, that both these Secretions are lessen'd by Sleep and Rest, and augmented by Watching and Exercise. *Sanctorius* in his *Aphorisms*, grounded on plain Facts and Experiments, confirms this beyond all Exception : but I shall chuse to confine myself here to the statical Observations and Experiments of our own Countryman, the learned Dr. *James Keil*, which must be supposed to be most accommodated to our Constitutions ; because they were all made in our

own Climate, and under the several Degrees of Heat and Cold with us, and thro' a successive Course of ten Years. From all which Experiments, made with great Assiduity and Care, it appears, that tho both the fore-mention'd Evacuations are subject to certain Augmentations and Diminutions, on the account of different Degrees of Heat and Cold, and the different regimen and way of Living with respect to the Non-naturals; yet in a mean Proportion and in a healthy State, the Quantity of perspirable Matter which passes off by Day, is to the Quantity of the same Secretion in the same time by Night, as 3 to 2: that is, the Quantity perspir'd in a given time in a state of Sleep and Rest, is but  $\frac{2}{3}$  of the Quantity perspir'd in the same during a state of Sensation and Action. And from the same Experiments it appears farther, that the urinary Discharge is likewise increas'd and diminish'd under the foregoing Circumstances respectively, and nearly in the same proportion with that of Perspiration. From whence 'tis evident in fact, that these two most considerable of all the expurgatory Secretions, are lessen'd by Sleep and Inaction, and augmented by Sensation and voluntary Motion.

THE Secretions of the *Saliva*, of the *Mucus* of the Nose, and of the Excrements thro' the Intestines, being but comparatively small in a natural State, cannot be so easily computed and judg'd of by Observations and Experiments: but when either of these happen up-

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on any occasion to be increas'd beyond their natural and ordinary Quantities, their Diminution and Remission by Sleep, is as great and remarkable as of the two former.

'TIS matter of common Observation, that they who by taking Cold discharge a great Quantity of *Saliva* and *Mucus*, have this Evacuation very much abated, and in a manner quite stopt and suspended during the time of Sleep; but the same Discharge immediately comes on again as soon as it is excited, and as it were ejected and forc'd off by the Stimulus of Sensation, and voluntary Motion in a waking State.

THUS likewise in those who are put under a Salivation by Mercury, the Flux is very much remitted, and in a manner suspended in the time of Sleep; by which it is diverted, turned inward, and carry'd about by the circulatory or lymphatick Glands; but comes on afresh, as soon as the Person awakes into a state of Sensation and Action. And the same thing is observable in a *Diarrhæa*, which is ever found to lessen and abate during the time of Sleep, after the same manner as in all the other expurgatory Secretions.

EVERY body knows the Power of Opium in easing Pain, procuring Sleep, and stopping a *Diarrhæa*; but they are very much mistaken, who attribute this last Effect to any occult Quality in the Opium, whereby it is supposed in some secret inexplicable manner to thicken and sopify the Blood and Humours, and at  
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the same time to charm, sooth, and pacify the disturb'd enraged animal Spirits: for indeed, all the Effects of Opium in lessening and abating the expurgatory Secretion, are owing to the Sleep which it procures, or that easy indolent State of ecstatick Quietude which is equivalent to Sleep; and the same Sleep or Indolence naturally coming on, or procur'd any other way, would have the same Effects. For let a Person under a Diarrhæa sleep naturally, and it may be observ'd, that the Matter of the Secretion which was before thin, sharp, and acrid, and which flow'd from the Orifices of the excretory Ducts in great abundance, will, during the time of Sleep, abate very much of its Quantity and Velocity; and as a Consequence of this, it must thicken and sopify by its slower Motion and longer stay in the secretory Canals.

FROM these Observations and Phænomena, 'tis evident, that all the expurgatory Secretions are lessen'd by Sleep and Quietude, and augmented by Watching and Exercise: now from the same Reason, and by the same Necessity it must follow, that the Secretions of the lymphatick Glands are increased, while the other is diminish'd, and *vice versa*; since the less the Quantity of Serum is which drains off from the Blood by the expurgatory Secretions, the greater will be the Quantity which remains to be taken up, and strain'd off by the circulatory or lymphatick Glands.

PROPOSITION XI.

THE lymphatick circulatory Secretions, by Sleep are increased in a greater Proportion than that in which the Evacuations, or expurgatory Secretions, are diminish'd.

THE mean Quantity of Perspiration in a Day, or 24 Hours, is 31 Ounces; and the mean Quantity of the urinary Discharge, is 36 Ounces: and if we suppose the Saliva, the Excrements by Stool, the Mucus of the Nose, &c. to be five Ounces, then will the Quantity of Urine be equal to all the other Evacuations. And because the Perspiration and Urine are diminish'd in the time of Sleep nearly as 2 to 3, 'tis evident that, *cæteris paribus*, the lymphatick circulatory Drain will be increased in the same Proportion, by the last Proposition. But there is another very considerable Cause of increasing these internal lymphatick Secretions in the time of Sleep, and that is the increas'd Velocity of the Blood, by which a greater Quantity of Matter will be carried to the Orifices of the secretory Ducts in the same time. 'Tis certain in fact that the Pulse is accelerated, and consequently the Velocity of the Blood increased by Sleep; this Acceleration is not fix'd to any one constant Ratio, yet 'tis confin'd within certain Bounds; so that a healthy Person, whose Pulse beats 80 times in a Minute by Day, shall in the Night, or while he is sleep-

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sleeping, beat from 80 to 112 times in a Minute: but the mean Proportion, and what is most common, is that of 80 to 96, which is the Proportion of 5 to 6. Now from both these Causes together, 'tis manifest, that the circulatory or lymphatick Secretions in the time of Sleep, will be increas'd in a greater Proportion than that in which the expurgatory Secretions are diminish'd.

### PROPOSITION XII.

*THE Quantity of any Secretion derived from the arterial Blood by the glandular, secretory Ducts, will be always in a Ratio compounded of the Momentum Motus, Serosity and Fluxility of the Blood.*

SINCE any such Secretion derived from the arterial Blood, must be drawn off thro' certain exceeding minute Tubes, or glandular Strainers, which spring from the capillary or evanescent Branches of those Arterys, before they are incurvated and return under the Name of Veins; 'tis manifest, that abstracting from all other Considerations, the Quantity of the Fluid thus secreted, will be proportional to the *Momentum Motus* of the Blood, or as the Quantity of Blood carry'd to the Orifices of these secretory Ducts, in a given Time.

BUT because the *Momentum* remaining the same, the Proportion between the globular Part or Crassament of the Blood, and the Serum, may be very different, the Quantity of

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of the arterial Secretions must necessarily vary upon this account: for since in a natural state of the Blood, nothing but the Serum can pass these glandular Secretorys which are too small to admit the Crassament or Blood-Globules, 'tis evident, that the Quantities secreted must be, *ceteris paribus*, proportional to the Serosity of the Blood, or as the Quantity of Serum contain'd in it with respect to the Crassament.

AGAIN, The *Momentum* and Serosity remaining the same, the Secretions must vary according to the different degrees of Viscidity or Fluxility of the Blood; for where the Serum itself is very crass and viscid, it will not pass so freely thro' the smaller Orifices of the glandular Secretorys, and consequently must pass in a larger Quantity and Proportion thro' the larger and more open Orifices of the capillary Arterys, and circulate with the Blood without any Secretion at all. Upon the whole therefore, the Quantity of any such arterial Secretion must be ever as the *Momentum*, Serosity and Fluxility of the Blood conjunctly, or in a Ratio compounded of these three.

### COROLLARY I.

HENCE, If the mean Quantity of any Secretion be given, the different Quantity of the same Secretion under any different and variable *Momentum*, Serosity and Fluxility of the Blood, may be presently found: for let the  
mean

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mean Quantity of any such Secretion from the Arterys be call'd Q, and the correspondent mean *Momentum*, Serosity and Fluxility M, S and F respectively; and let any different and variable Quantities of the same kind be design'd by the smaller Letters of the Alphabet *q, m, s, f* respectively; then  $Q : q :: MSF : m s f$ . And therefore  $Q m s f = q MSF$ ; and consequently it will be  $\frac{Q m s f}{M S F} = q$ . And be-

cause  $\frac{Q}{M S F}$  may be taken as a standing Quantity, it may be call'd R; and then  $R m s f = q$  will determine the Quantity of any variable arterial Secretion universally.

### C O R O L L A R Y II.

THIS being the great Law and Condition of all the arterial Secretions, it must follow, that where any of the natural Evacuations of Lymph or Serum are not govern'd and directed by this Law, but are made in Quantities and Proportions very different from it, and repugnant to it; such Evacuations cannot be deriv'd from the Arterys, but must be supply'd in their different variable Quantities some other ways: which has not been hitherto understood or explain'd. And that this is really the case I shall now prove, by applying the general Principle to the urinary Evacuation, which is perhaps the largest and most considerable in the whole Body, and of which a particular Computation may be easily made.

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IN order to which, I shall suppose that the Heart throws 2 Ounces of Blood into the *Aorta* at every Systole, and that it makes 75 Pulsations in a Minute; then will there be 150 Ounces pass thro' the *Aorta* every Minute, and 1800 in the Space of 12 Minutes. The Velocity of the Blood decreases at every Division of the Arterys from the Heart, as the Sum of the Sections of the Arterys increase, by *Prop.* 3. but this Increase of the Sections, and Diminution of Velocity, obtains not every where in the same Proportion; but is less in such Divisions of the Arteries as are near the Heart, and greater in those that are more remote. The mean Proportion of the Trunk to the Branches is as 100 to 126. I shall suppose the Proportion of the Trunk to the Branches between the Heart and the Emulgents to be only as 100 to 103, which is the least that has ever yet been observed. The number of Divisions from the Heart to the Emulgents is about 30; it may be one or two more or less, for the number is not exactly the same in all Bodys.

Now upon this Supposition, the Velocity of the Blood at the Heart, will be to its Velocity in the Emulgents nearly as 25 to 10, or as 5 to 2, by the Method of Computation in *Prop.* 3. The Section of the *Aorta* at the Heart is to the Sum of the Sections of the emulgent Arterys at least as 12 to 1; and consequently the Quantity of Blood passing thro' the Heart in a given Time, will be to the

Quantity

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Quantity passing thro' the Emulgents in the same Time as 30 to 1; and therefore, if the Heart throws off 1800 Ounces of Blood in the Space of 12 Minutes, there can only 60 Ounces pass thro' the Emulgents in the same Time.

I HAVE made this Computation to the utmost Advantage in favour of the arterial Secretions, by admitting a greater Velocity of the Blood, or a greater Quantity passing thro' the Heart in a given Time than can be reasonably supposed; and if only one Ounce of Blood be thrown into the *Aorta* at every Systole, which is the most common Supposition, then there would be but 30 Ounces pass thro' the Emulgents in 12 Minutes. And here it must be observed, that of the mix'd Mass which circulates thro' the Blood-Vessels, one half at least is ordinarily Crassament, or such Serum as strongly adhering to the Crassament cannot be secreted or drawn off by the glandular Secretorys, and consequently cannot contribute to the Augmentation of the arterial Secretions at all. The mean Quantity of Urine secreted in 24 Hours is about 36 Ounces, according to the Experiments of Dr. James Keil, where there are no extraordinary Quantities of Liquor taken in, but just what is sufficient to dilute the ordinary Food, or to quench the moderate thirst of a Person in health, and not using any heating Exercise: but 36 Ounces in 24 Hours is  $\frac{3}{4}$  of an Ounce in 12 Minutes. And because  
only

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only one half of the mix'd Mass consists of separable Serum, or such as is capable of passing off by the secretory Tubes; therefore if the Emulgents should be supposed to flow only with Serum, or with a Fluid like common Water, there must be a double Quantity of such Fluid secreted in the same time; that is, 0,6 of an Ounce in the space of 12 Minutes, or 3 Ounces in an Hour. And this is the utmost Quantity of Serum that can be drawn off from the emulgent Arterys in that space of time, upon any Supposition whatever consistent with animal Life and Motion.

In this case, where the Serosity and Fluxibility of the Fluid circulating thro' the Emulgents are such, as to admit its passing thro' the emulgent Capillarys and Bellinian Tubes equally and indifferently, the Sum of the Sections of the emulgent Capillarys will be to the Sum of the Sections of the Bellinian Tubes as the mean Quantities passing in a given time, *i. e.* upon the present Supposition, as 60 Ounces to 0,6 of an Ounce, or as 100 to 1. This is where the Heart throws out 2 Ounces into the *Aorta* at every Contraction: but if a greater or less Quantity of Blood be supposed to circulate thro' the *Aorta* in a given time, the foregoing Ratio of 100 to 1 must be increased or diminish'd in proportion to the Quantity directly.

BUT because the Fluid passing thro' the Emulgents cannot be supposed to be all Water, and capable of being carried thro' the

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Bellinian

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Bellinian Tubes equally as in the Capillarys of the emulgent Arterys themselves, therefore the Proportion last assign'd must be too large, and the Quantity drawn off by the Bellinian Tubes cannot be  $\frac{1}{10}$  part of what passes thro' the Emulgents in a given time. Let us suppose then the whole Quantity of Blood contain'd in a human Body to be 30 Pound; for tho it is in all probability more, yet it cannot be less. Let us also suppose this Quantity to be increased by 6 Pints of Water, or some thin Liquor passing into the Blood and equally mixing with it at once, or in a very little time before any Secretion begins; and let the *Momentum*, Serosity and Fluxility of the Blood be hereby increased as 36 to 30, or as 6 to 5: then must the urinary Discharge be increased as the Cube of 6 to the Cube of 5, that is, as 216 to 125. And consequently the mean Quantity of that Evacuation can be increased only from 0,3 to 0,52 of an Ounce in 12 Minutes. These are all liberal Allowances, and no arterial Secretions can be made in larger Quantities than according to these Laws; but the real Quantity of Urine derived into the Bladder, and discharged in 12 Minutes, may be, and often is, 30 Ounces, or even more, as is well known. That is more than could be derived from the Arterys in the same time, by above 60 to 1: nay, the largest Evacuations by Urine, Sweat, Stools, &c. are often made where the Force and Velocity of the Blood is least, as in hypochondriack and hysterick

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hysterick Faintness, Deliquiums, &c. as all know ; that is, these are increased while that is diminish'd, contrary to all the Laws of Motion, supposing such Derivations to be made from the Arteries.

SCHOLIUM.

WHAT has been offer'd under this Proposition is a full and sufficient Demonstration, that the natural Evacuations in their different and variable Quantities, cannot possibly be deriv'd from the Blood by the arterial Secretory Ducts ; and consequently that they must be supply'd in some nearer and more direct way, without any such intermediate Drain from the Arterys. What now remains is an anatomical Account and Explication of this Principle ; or to shew from the Structure and Constitution of an animal Body, that there is, and must be such an immediate and direct Communication from the Stomach to the Kidneys, and to the several other Emunctorys and excretory Ducts of the Body, without passing the commonly supposed Course of Circulation thro' the Blood-Vessels. That this is really so in fact, I think has been clearly and unanswerably demonstrated already, from the known establish'd and necessary Laws of the Circulation of the Blood. But how this comes about, or after what manner such Communication is made, has not been hitherto explain'd or understood. Nay, the

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contrary has been always supposed and asserted without Proof, and even against all the Laws of animal Motion.

BUT in order to set this matter in a clearer Light, it will be necessary to consider the Structure and Constitution of an animal Body with regard to that vesicular Coat which was known to the Antients by the name of the *Panniculus Adiposus*, and which the Moderns call the *Membrana Cellulosa*.

IT consists of a Compages or Congeries of very small Lymphaticks, with their appending Vesicles or adipose Cells, which communicate with each other by their common *Tubuli* or Lympheducts, and are capable of a most prodigious and almost incredible Distension from the least Force. This cellulose Membrane is thrown over all the moveable parts of the Body, and may be found every where between the Skin and the muscular Flesh. It is tied to the Skin which lies over it, by an Infinity of small transverse Fibrillæ springing from the small Arterys that are spread upon the Skin; but it has no Adhesion at all to the subjacent Muscles. By this means the Muscles may move freely up and down, and their Tendons may be drawn forwards or backwards with all imaginable ease, the Skin at the same time remaining at rest. But where, by any Accident, this Membrane happens to be eroded and consumed, the Skin presently adheres and grows to the subjacent Muscle, and so

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so far suspends or hinders its Action. And 'tis remarkable that where the Muscles are contriv'd and design'd for the greatest share of Motion, there this Membrane is thickest and fattest, as about the Breast, Abdomen, Back, Loins, Buttocks, Thighs, Legs and Neck; but where the Muscles are small, and not very liable to Motion, there this Membrane is stock'd with so small a Quantity of Fat, that almost all Anatomists in general reject an adipose Membrane, and only *Ruyfch* admits of a cellulose one: thus they disallow of it in the Head, the Eye-lids, the Face, and the Scrotum; but unjustly, for it certainly exists in those Parts, but is so much thinner there than at the Buttocks, as the Elevator of the upper Eye-lid, or the *Corrugator Frontis*, are less than the *Glutæi*.

AND as this Membrane serves to lubricate between the Skin and the moving Muscles, so its Communications perform the same Office among the Muscles as they regard each other, by enveloping each of them separately, whether great or small, thro'out the whole Body; so that one can never actually touch another, or any particular Muscle adhere to, or rub against its contiguous Muscle, but the one may move with all possible ease and freedom, while the next to it is at rest. And from hence 'tis as easy to distinguish between Muscle and Muscle, as between the Muscles and the Skin that covers them: nor are the

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Muscles themselves only thus sheath'd and guarded, but likewise their Tendons; in consequence of which they are easily pull'd forward and backward without any sensible Friction or Retardation.

FROM the Tendons and Heads of the Muscles, this Membrane is continued to the Superficies of the Periosteum, and so to the Bones; and expands itself over the Ligaments of the Joints, and even insinuates itself between the Viscera and their Meninges, as the Membrane of the Thorax and the Expansion of the *Peritonæum*. And that Portion of it which is destin'd to any one Muscle, is still farther divaricated and dispersed among the Interstices of that Muscle, which consists of the several Parts into which it is artificially divisible, so that each of these may move separately and distinctly among one another: and the same obtains even in every particular Fibre of the whole Muscle.

Thus is the Progress of this cellulose Membrane, from the internal Surface of the outer Skin, and from the Coats of the Stomach and Intestines, thro'out all the numberless Divisions and Subdivisions of the Muscles, even to the Tendons and *Periosteum*, and consequently to the Marrow of the Bones, anatomically demonstrable. And after it has supply'd with the oily Parts of its Lymph, the cellulose Fat, the Mucilage of the Joints, and the Marrow of the Bones; the superfluous

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ous or excrementitious Serum is return'd by the small Vessels of this Membrane, to the several Emunctories and excretory Ducts of the Body, to be thrown out as useless, and make way for a fresh Supply.

THIS cellulose Membrane in a Body highly fed and fatten'd, is so prodigiously fill'd and distended with Fat in all its Divisions among the Muscles, that its Contents are more in Substance and Weight than all the rest of the Body, in the Proportion of 3 or 4 to 1; but in a *Marasmus* and *Atrophia* it is so empty'd, that the Tunick itself is almost invisible, and can scarce be separated or distinguished from the Skin that covers it, and to which it grows and adheres. In a *Leucophlegmatia* these Cells are fill'd only with Water; and in an *Emphysema* they are monstrously turgid and inflated with Wind or Air.

In the Great or *French Pox*, the venereal Virus fixes upon this Membrane as its original proper Seat and Subject: and the subjacent Muscles are not at all affected by it, or touch'd with it, till the cellulose Membrane has been quite eroded, putrify'd and consum'd, clear up to the Tendons of the Muscles and the Periosteum of the Bones. Which is an evident Proof of what is likewise demonstrable at any time, by Inspection only; that this Membrane has very little or no Connexion or Communication with the Blood-Vessels, and must consequently be fed and supply'd by the

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Chyle

Chyle directly from the Stomach, as much as the Blood-Vessels themselves.

As what I have here offered concerning the Structure, Propagation and Use of the *Membrana Cellulosa*, is a matter of fact, and must depend upon Authority; I have given this Account of it almost in the very Words of the learned and celebrated *Boerhaave*, in the Preface to his *Aphrodisiacus*, or Collection of original Tracts relating to the venereal Disease: from whom only I have been able to borrow any Light or Assistance upon this important Subject; and to whom this great and noble Discovery in Anatomy must be due: A Discovery of vastly greater Moment, and more general Use, than any thing hitherto deduced from the Circulation of the Blood; since hereby the most difficult and otherwise inexplicable Appearances and Symptoms of Diseases, may be easily understood, and clearly accounted for.

HENCE we see how the most distant, remote, and, to appearance, independent Parts of the Body, may have a necessary and direct Communication with each other. From hence we may understand how it comes about that all the Fat and Lymph of this cellulose Membrane, tho it be sometimes double in Quantity and Weight to the whole Body besides, may yet be evacuated and discharged by Urine in a Diabetes, by Sweats and Stools in a Hectick, by an Ulcer in any part of the Body,

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Body, or thro' the salival Ducts by the Force of Mercury ; while the state of the Blood is not sensibly alter'd, but remains much the same with regard both to its Quantity and Quality. From this Principle we may understand and explain the several Appearances and Symptoms of hypochondriacal and hysterick Disorders ; of the Scurvy, whether it affects the outward Skin, the Viscera, the Mucilage of the Joints, or the Periosteum and Bones. And from hence we may account for that great and general Corruption of the Lymph in the Glands and small Vessels of the adipose Membrane, which sometimes happens from a vitiated Digestion ; while the Blood, upon Phlebotomy, is found to be florid, rich, and good.

AND thus we see after what manner the Stomach actually communicates not only with the Kidneys, but with all the other excretory Ducts and Outlets of the Body, and this immediately and directly, without any regard to the arterial Secretions : and therefore this great and necessary Law of animal Motion and Secretion, is now not only demonstrated as physically true in fact, but likewise anatomically explain'd and accounted for.

PROPOSITION XIII.

*To explain the Origin, Formation, and Constitution of glandular Diseases.*

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THE original secretory Ducts or glandular Strainers, thro' which the Serum or Lymph is drawn off from the Blood in the Arterys, and their secondary conveying Pipes, by which it is propagated from the Glands, and distributed to its several Receptacles and Outlets, being extremely minute, consisting of very thin and tender Coats, and endu'd with but a very small degree of muscular Force; are, upon these accounts, the most liable to Obstructions, immoderate Distensions, Erosions and Dilacerations, of any in the whole Body.

AND from hence a multitude of Symptoms arise, and distinct Diseases are form'd, which have been hitherto either so little understood or so oddly explain'd, that this morbidick Constitution has been generally allow'd as the *Opprobrium & Flagellum Medicorum*, the common Reproach and Scourge of Physicians: for all the Diseases under this general Constitution, excepting perhaps a Dropsy and a *Phthisis*, or Ulceration of the Lungs, have been call'd *Nervous*, and ascrib'd to the intemperate Sallies, the irregular Explosions, and the eccentric Motions of the disturb'd animal Spirits; which is a Cause certainly more mysterious than any Distemper in the whole Body.

BUT that I may, at least in some measure, free this part of the Theory and Practice of Medicine from such Generality, Confusion and Uncertainty, I shall here consider the principal morbidick Dispositions of the Lymph  
and

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and glandular Secretions: and this may perhaps serve to account for some of the most abstruse Phænomena of Diseases, without recurring to a Cause still more abstruse than the Phænomena themselves.

Now the Lymph or Serum of the Blood, which is continually draining off thro' the lymphatick and expurgatory Glands, may become morbifick, either on the account of its *Quantity* or *Quality*; and both these morbid Constitutions of the Serum, respecting either its *Quantity* or *Quality*, depend so much on the urinary and biliary Secretions, that the one cannot be understood or explain'd without the other: and therefore I shall consider them both together, that their original morbid Constitutions, and their several Phænomena may be seen in their proper genuine Production and Formation.

I. THEREFORE, the urinary Pipes and Aqueducts from the Stomach and Blood into the Bladder being the principal Water-drain, by which the greatest part of the Liquors taken in are discharg'd again out of the Body; where these are obstructed, and the *Quantity* of Urine considerably diminish'd, the necessary Consequence of this must be a Surcharge of Serum in the Blood; which running off too fast upon the Glands and Lymphaticks, and overstretching, dilating, and distending them, a Dropsy must ensue: and from hence there will arise different Appearances and Symptoms, according to the different State  
and

and Circumstances of the overstretch'd distended Glands and Lympheducts, and the particular Parts upon which the principal Bulk and Surcharge of the Water is thrown.

THE Mesentery and the Caul, being all glandulous and abounding with an infinity of Lymphaticks, thro' which the largest Quantities of Lymph are drawn off from the arterial Blood, are therefore most liable and the first disposed to a Distension and Tumefaction, upon any great or long continu'd Obstruction and Diminution of the urinary Drains; from whence the Inundation soon spreads, and distends the Spleen, the Liver, Stomach, and all the parts of the Abdomen; and lastly, the whole Body is swell'd and bloated from Head to Foot.

BUT this universal Dropsy, or *Anasarca*, is often prevented by a worse Accident; for it frequently happens, that the Liver, Spleen, Caul and Mesentery, some or all of them corrupting, and their Lymphaticks breaking, the Water is let out into the Cavity of the Abdomen; which renders the Case desperate. For tho any present Load of Water may be let out of the Belly by Tapping, yet it will be still collecting and filling up again from the broken Lymphaticks; till Nature being quite wasted and worn out, the Patient dies; having all his Bowels and the principal Organs of Life soak'd, tainted, and putrefy'd in the stinking corrupt stagnating Water.

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THESE two sorts or rather degrees of a Dropſy, the *Anasarca* and *Ascites*, manifeſtly conſiſting in a Redundance of Water, from an Obſtruction of the urinary Pipes, and Strainers, the animal Spirits have not been ſo much blam'd; and every body allows the Diſtemper to be owing, not to highly refin'd rectify'd Spirits, but to ſtinking, corrupt, and putrefying Water.

BUT there is another ſort of Dropſy, which lying more latent and conceal'd, has been generally taken for a pure nervous Caſe, and its Symptoms accounted for from the *Doctrine of Animal Spirits*; an Hypotheſis, ſerving in Phyſick to explain all thoſe Diſeaſes which the Phyſicians have been ignorant of or ſurpriz'd at, like the common Refuge of Conjuratiſon or Witchcraft among the Vulgar. The Dropſy which I here intend, is the internal *Hydrocephale*, or Dropſy of the Brain, of which the Symptoms and peculiar Phænomena are ſo very different from thoſe of an *Anasarca* and *Ascites*, that they are commonly aſcrib'd to a quite different Cauſe, to the great Detriment of the Patient, and Diſappointment of the Phyſician.

'TIS well known that the Brain is provided with a great number of lymphatick Glands: for beſides the Pineal, the Pituitary and Choroidal Glands, which are ſufficiently viſible and remarkable, the *Pia Mater* is all over bedeck'd and interlac'd with an infinity of ſmall Glands of the lymphatick Kind, which in  
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their natural State cannot be seen without a Microscope ; but when this Membrane has been soak'd sometime in warm Water, or when these Glands are preternaturally tumify'd and distended in a *Hydrocephale*, they are visible enough to the naked Eye. Now all the lymphatick Glands of the Brain, thro' which the Lymph is drawn off from the ultimate Branches of the cervical and carotide Arterys, uniting in larger Canals, convey their secreted Lymph to the jugular Veins, where it is empty'd into the Blood. And this is sufficiently evinced by injecting any tinged Liquor thro' the *Infundibulum*, where the Lymphaticks of the Brain unite ; which Liquor will freely pass into the jugular Veins, but cannot in the natural State and Situation of the Organs pass any other way.

WHEN these Glands and their Lympheducts are obstructed, so as not to send off their Lymph to the Veins as aforesaid, the Consequence is a Dropsy of the Brain, or an internal *Hydrocephale* ; of which the Symptoms will be various, and more or less severe, according to the Nature of the Obstruction, and the Quantity of the Lymph detain'd and pressing upon the Nerves and Blood-Vessels. While the Glands and their Lymphaticks are only immoderately distended and dilated, but not broken, the Symptoms are Heaviness, Lassitude, and a general Weakness of the Muscles ; a listless Unconcernedness about things, Drowsiness, and an almost continual Disposition to Sleep,

Sleep, with an unusual Tendernefs or Incapacity of bearing the leaft Excefs of Heat or Cold, either with refpect to the external Air, or the internal ufe of Drinks and Medicines. When the Obstruction, Dilatation and Diftention become greater, the Difease discovers itfelf in vertiginous and paralytick Symptoms, and difpofes to Lethargys, Epilepfys, Apoplexys, and *fpaſmodick Deliquia*: but when theſe Glands and Lymphaticks inflame, break, and let out their contain'd Lymph upon the Brain, or between the Meninges, the caſe is altogether deſperate, and the Patient ſoon dies paralytick, convulſed, and under a ſtupid drouſy ſort of Raving.

HOWEVER, while the Diſtemper is only growing, and before the Lymphaticks break and extravafate the Water upon the Brain, there is hope of a Cure, provided the moſt effectual Methods are taken to derive and draw off the Water from the Head, by long continued moderate Purgings, Iſſues, Setons, Bliſters, &c. but all volatile oily Salts, ſtrong ſpirituous Liquors, heating Cordials, and every thing which determines the Blood and Humours in a greater Quantity than ordinary to the Head, are moſt certainly hurtful, how much ſoever they may be ſometimes uſed and cry'd up, under a pretence of awakening and rouſing up the animal Spirits, and delivering them from their ſuppoſed Oppreſſion and Suffocation. But,

2. To consider another Effect of this morbid urinary Secretion: It sometimes happens, that the primary Drains, and thinnest part of the Urine, pass off very plentifully in sufficiently large, or perhaps too great Quantities; while the grosser Salts, Earths, and other thick and gritty Recrements, which ought to be strain'd off and discharg'd thro' the Kidneys, are retain'd in the Blood from some Weakness, Dilatation, or Obstruction in the renal Glands, which cannot make this due and necessary Secretion: and this gross, salt, and fabulous Matter, being retain'd in the Blood and mix'd with the Serum, must pass together with the Lymph thro' the other Glands and lymphatick Strainers, in a preternatural way. And from hence the Glands in different Parts being gradually fill'd with this gross, urinous, salt and slimy Sabulum, will at length be totally obstructed, and very much dilated and distended with it, and thereby form various sorts of œdematous and schirrous Tumors; which Tumors at last suppurating and running into Ulcers, produce a great variety of different Symptoms and Appearances, more or less severe and grievous, according to their several degrees of Malignity, and the particular Parts affected: and this is what I chuse to call in general *the Scorbutick Constitution*. Of which general Scorbutick Constitution, I shall here consider some of the principal Modifications and Phænomena.

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IN the first place therefore, the Serum of the Blood being plentifully stock'd with this gross, salt, and slimy Sabulum, which cannot be drain'd off by the Kidneys, a great Proportion of the thickest and grossest Part of it must necessarily pass thro' the Spleen; in which the Blood-Vessels and Lymphaticks are the largest of any other glandulous Organ of the Body: and consequently while the thinner Parts are carried off, and the thicker and grosser lodg'd upon the Glands, the Spleen will be first obstructed, indurated and tumefy'd, from such a Cause as we are now considering.

IN the next place, the Mesentery, in which an Infinity of lymphatick Glands are interwoven, and complicated thro' its whole Substance, will consequently be obstructed, harden'd and tumefy'd, from the same Cause and by the same Means as before; and from this Distension and Tumefaction of the Mesentery, the Intestines must be compress'd and constipated, their peristaltick Motion, or the muscular Action of their Coats lessen'd and diminish'd, and the Protrusion and Expulsion of the Excrements hinder'd and obstructed: from whence the Stomach and Bowels will be fill'd with a windy Flatus, occasioning sour, hot, sharp, acrid and stinking Belches, Cholick Gripes, immoderate Distension of the Stomach and *Viscera*, asthmatick Suffocations, and very often a sort of drunken, delirious, or maniacal strength and wildness of Imagination, from the immoderate Afflux of the Blood to the

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Head. On the other hand, while the Intestines are thus compress'd and constipated by the tumefy'd indurated Mesentery, any strong Catharticks, low, cooling, cleansing Liquors, acid mineral Oils and Spirits, and whatever tends to move the Blood and Humours downwards, by irritating and stimulating the Stomach and Intestines, which have in great measure lost their muscular natural Force, must produce Faintness, Tremblings, *Deliquia*, a low Pulse, cold Sweats, and a terrify'd Imagination, impress'd with all the Images and Ideas of Fear and Grief.

THE Spleen and Mesentery, to which we may add the *Epiploon*, being thus tumefy'd, and their Glands obstructed, the Lymph cannot be drawn off in sufficient Quantities from the Arterys; and consequently the Blood will be sent into the *Vena Porta* and to the Liver, not sufficiently drain'd and depurated of its thinner Serum: from whence the Liver, instead of secreting the pure Bile, will drain off only a low, watry, salt, and fabulous Liquor, coming near to the Nature of Urine; while the proper volatile oily Salts of the true and natural Bile will be left in the Blood: and these mix'd with the grosser fix'd Salts and slimy Sabula of the Urine, which cannot pass the Kidneys, ferment with and corrupt the whole Serum of the Blood, by rendring it hot, sharp, acrid, pungent, extremely penetrating, and in a manner corrosive; and the Serum thus corrupted, fused, and sharpen'd, must

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must dispose the Tubercles and Tumors of the Spleen and Mesentery, to suppurate and run off into putrefying Ulcers: from which Erosion and Ulceration, there must ensue a *Tabes*, an Hectick, and a general wasting or consumption of the Flesh and Fat. From all which Symptoms, thus deriv'd from their natural Production and original Cause, 'tis plain that this which has been here describ'd is the hypochondriack and hysteric Constitution; and that they who are so affected, labour under a true and proper splenick and mesenterick Scurvy.

WHEN the same urinous, salt, slimy, and fabulous Matter happens to be thrown upon the Glands of the Bronchia, it produces the Tubercles, Tumors, and Abscesses of those Glands, or an Ulceration of the Lungs, which is properly a bronchial Scurvy: and here where the true Cause appears, the animal Spirits are no longer blam'd, as they generally are while the Scene is acted deeper, and the Disease lies more latent in the glandular Organs of the Abdomen.

IN short, there are no Glands thro'out the whole animal Body, but what may be affected after the same manner, and their Blood-Vessels, Nerves and Lymphatics tainted, eroded and ulcerated by this salt, sharp, fabulous, bilious, and corrosive Serum, which often corrupts, putrefies, and eats off the Ligaments and Bandages of the Joints, dissolves the Union of the Cartilages and Bones, and soaks

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thro' and swells the Bones themselves, canker-  
ing, corrupting, and mortifying them. The  
Leprosy in all its dismal Appearances, and the  
*Lues Venerea*, are owing to the scorbutick  
Cause rais'd to a higher Malignity.

#### PROPOSITION XIV.

*TO explain the Origination, and essential  
Constitution of FEVERS in general.*

IN order to come to any Certainty about  
the natural Production, essential Constitution  
and Cure of Fevers, it will be necessary to  
consider the peculiar Characteristicks of a Fe-  
ver, or those common Symptoms which at-  
tend all Fevers, and by which a Fever is out-  
wardly and sensibly distinguish'd from all other  
Diseases. Now these common Characteristicks,  
or visible Appearances which in some degree  
or other sensibly attend every Fever, are these  
which follow.

I. A QUICK, unequal, irregular Pulse.

II. A LABORIOUS and disturb'd Respira-  
tion.

III. AN equally fluid, high colour'd shining  
Urine, with a Diminution of its Quantity,  
especially in the Febrile Paroxysm.

IV. A PARCHEDNESS and driness of the  
Tongue, Mouth and Throat, with a clammi-  
ness and viscosity of the Saliva, attended with  
a consequent heat and thirst.

V. AN

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V. AN inflammatory painful Restlessness, preventing, interrupting, or disturbing the natural Sleep.

VI. Loss of Appetite, and a general Nausea and Reluctancy of the Stomach against every thing but thin diluting Liquors.

I do not pretend that all these Symptoms are equally apparent in every Fever, tho I think there is no Fever but where they are all to be found in some degree or other; and some of them, at least, so distinct and sensible, that every judicious Observer will easily pronounce whether the Person has a Fever or not.

Now from these Symptoms 'tis manifest, that in every Fever there is a general Obstruction and Diminution of the glandular Secretions; I mean, that a great part of the Lymph or Serum of the Blood, which ought to be continually drain'd off, both by the conservatory and expurgatory Glands, is during the Fever so retain'd in, and closely united to the Mass, that it circulates together with it in the Blood-Vessels strictly so call'd, *i. e.* in the Arterys and Veins.

To shew that this is really and in fact the State and Constitution of the Blood in the Production and Formation of a Fever, it will be necessary here to apply the general Principle to the fore-mention'd particular Symptoms; by which it will be evident, that all those Phenomena or sensible Appearances of Fevers,

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are the just and adequate Effects of such a Cause. For,

1. THE Lymphaticks being obstructed, and thereby the Influx of the cool'd, diluted Serum from the conservatory Glands being intercepted, 'tis manifest that the Blood upon this occasion must acquire a preternatural Heat; and from hence the Serum of the Blood will become too viscid, glutinous and renacious, which is the well-known Consequence of its being over-heated.

2. THE Serum being thus retain'd by its Heat and Viscidity in the common Mass, and not flowing in a sufficient Quantity and a due Velocity in the Lymphaticks and secretory Ducts of the Glands, 'tis plain that a greater Quantity than ordinary of the Fluid must now circulate thro' the Blood-Vessels, *i. e.* the Arterys and Veins. And from hence, partly by the increas'd Quantity, and partly by the Heat and Rarefaction of the Blood, there must ensue a Plethora of those Blood-Vessels; and from hence a preternatural Distension of the small capillary Arterys in the Glands and Muscles, with Heat or inflammatory Pain.

3. THE hot viscid rarefy'd Blood, distending and inflaming the Glands and muscular Flesh, must act as a *Stimulus* upon the Nerves or muscular elastick Fibres, and excite them to strong and violent Vibrations or Efforts, in order to remove the increased Weight and Resistance of the Blood, and carry on the Circulation. And these Vibrations and Efforts of

the Nerves will be different and unequal, according to the Nature of the *Stimulus*, and the different Parts affected by it. And this must produce a quick irregular Pulse, and a laborious and disturb'd Respiration.

4. THE Serum being detain'd by its Heat and Viscidity in the Blood, and not passing as usual thro' the Lymphaticks and secretory Ducts of the Glands, a small Quantity only of the Saliva will be shed off; which therefore by its slow Motion will grow thick and clammy: and by means of the small capillary Arterys, distended with hot rarefy'd Blood every where dispersed, and pressing upon the salival Glands, the Tongue, Mouth and Throat will be parch'd and dry'd, the Saliva harden'd and incrustated about the Tongue and Palate, and produce a Heat and Thirst. And for the same Reason 'tis evident, that only the thinner and more fluid Parts of the Serum will be strain'd thro' the Kidneys; and consequently the Urine will be small in Quantity, of an high florid Colour, and with little or no Sediment or Separation of its Parts.

5. IN this Case, and for the Reasons already mention'd, the Stomach being heated and inflam'd with the hot rarefy'd Blood, every thing contain'd in it will be apt to ferment, rarefy, and work up into an indigested Flatus; and the Lacteals at the same time being compress'd and constipated by the distended turgid Blood-Vessels, will admit of nothing from the Stomach but what is very thin and fluxile: and

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therefore the work of Digestion will be interrupted and perverted, Nature will loath and reluct against any thing of Food or Aliment, and the Person will covet nothing but thin diluting Liquors.

Now after this account of the general Origination and Constitution of Fevers that are true and simple, it will be necessary to consider the natural Solution of such Fevers, and by what means the Business is effected, when the Cure is left to and perform'd by Nature alone, without the Assistance of Art: and this is of such Consequence, that it will be impossible to determine any thing certain about the Cure of Fevers, without carefully following the Footsteps of Nature, and making that our principal Guide and Rule.

DURING the Rise and State of a true Fever, such as I am now considering, the expurgatory Secretions are in a great measure suspended, or very much lessen'd and abated: the Saliva flows but in small Quantities; the external Surface of the Body is parch'd and dry, with little Appearance of Sweat or Perspiration; the first Urines, or such as at other times are drain'd off directly from the Stomach to the Bladder, are now quite stopt; the fix'd Salts and earthy Sediments of the Blood, which usually pass off by the Kidneys, are now kept back, and only a small Quantity of the heated Serum passes these urinary Discharges. That this Detention of the serous Evacuations is the necessary Consequence of a Fever, we have  
seen

seen already, and by what means it comes about : what now remains is to show that this, which is the *necessary Consequence*, is also the *natural Cure* ; or the Method by which Nature, *i. e.* the Machine, relieves and succours itself, provided the Enemy be not too strong.

FROM what has been said I presume it may be sufficiently evident, that the Heat, Rarefaction, and Viscidity of the Blood, must be necessarily increas'd upon any Obstruction of those Lymphaticks which are deriv'd from the conservatory Glands, and by which the heated Serum ought to be receiv'd from the Arterys, and return'd cool'd and diluted upon the Blood in the Veins ; and consequently that such an *Obstruction* or *Diminution* must produce a *Fever*. Now in this case, should the Serum or thinner part of the Blood be thrown off too fast in any of the expurgatory Secretions, the remaining part of the Mass must be still more hot and viscid ; the head Blood-Globules being depriv'd of their diluting Serum, will be excited into the most violent intestine Motion ; and this Tumult and Effervescence of the heated viscid *Crassamentum*, acting as a *Stimulus* upon the muscular Coats and Fibres of the Blood-Vessels, will excite the nervous System into such strong and violent Efforts, in order to carry on the Circulation, and remove the growing Weight and Resistance of the turgid rising Blood.

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BUT the Serum still diminishing, and the Heat, Effervescence, and intestine Motion of the *Crassamentum* increasing, Nature will soon be brought to her last Struggles in continual Watchings, Deliria, Ravings, purple, black, and livid Spots upon the Surface of the Skin; bloody Secretions, Gangreens and Mortifications of the glandulous and muscular Flesh; a trembling intermitting Pulse; an hot suffocating Breath, *Deliquia*, soporiferous Stupors, convulsive Sighs, with other such-like dismal Harbingers of a general Wreck, which come to give the By-standers notice of approaching Death.

NOW to prevent this Tragedy, as soon as a Fever commences, and threatens an Inflammation, Nature takes care to shut up all the Sluices and Outlets of the Serum, that as much as possible of the thin and aqueous Parts of the Blood may be retain'd, to dissolve and dilute the *Crassamentum*, till the Quantity of the Serum be increas'd, so as to be capable by its natural Weight and Impetus to make its way again into the obstructed Lymphaticks; which being done, and the Blood thereby sufficiently condensed, cool'd and diluted, the excretory Ducts and Orifices of the expurgatory Glands are by the Action of Nature open'd again, in order to let out the morbid Serum which has been accumulating, corrupting, and putrefying in the Lymphaticks, during the Rise and Progress of the Fever.

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THE manifest Diminution of all the Evacuations, or expurgatory Secretions in a true and regular Fever ; the Care of Nature in shutting up the small Pipes and Passages of the first Urines, that a greater Quantity and Proportion of what is drank may pass into the Blood ; the plain Voice and Law of Nature express'd in the painful Sensation or *Stimulus* of Thirst, and commanding a free and plentiful use of thin diluting Liquors ; and especially the many dangerous Consequences which are always found by Experience to follow from any large symptomatical Evacuations in a Fever, where the Serum is thrown off in Sweats or Stools before it had done its proper work, by preparing the Blood for a due Crisis, or a regular Solution of a Fever : All these Facts put together, I think, afford us a sufficiently clear and full Proof of the truth of this Theory, concerning the natural Production, Constitution, and Solution of a Fever.

### COROLLARY.

FROM what is here said it is manifest that there are three very different and remarkable States and Periods to be observ'd and distinguish'd in every Fever : The first is the State or Period of its arising or generation, while the Heat and Rarefaction of the Blood is still increasing, and the Influx of the Serum thro' the Lymphaticks more and more obstructed and diminish'd.

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THE second is its constituent, fix'd and standing State, or that Period in which the Fever having obtain'd its full Growth and perfect Formation, retains its whole Form and Constitution for a time, while Nature is employ'd about the most nice and difficult Work, in order to bring about a salutary Crisis.

THE third and last State of a Fever is the Crisis, or that Period in which the Blood condenses, dilutes and cools; and the Serum taking its due Course again thro' the Lymphatics, the stagnated, corrupt, and putrid Lymph or Serum is wash'd off, and thrown out in the critical Discharges of Sweat, Urine, Stools, &c. But if Nature cannot bring about a salutary Crisis, and be not assisted by Art, this Period puts an end to the Disease and Life together.

### COROLLARY II.

FROM hence it evidently follows, that the most proper and seasonable time for the assisting of Nature, and in which the Advice of a Physician who understands his Business will be of the greatest Consequence, is the first arising or generating State of a Fever.

SUCH is the inimitable Wisdom and Contrivance discover'd in the Structure and Constitution of an animal Machine, that more Fevers are prevented and restrain'd by the Care and Providence of *Nature*, than are ever cur'd by the *Physicians*. And indeed, where Nature obtains her first Intention, which is to  
throw

throw off the generating Principles and original Stamina of the Disease, there is no need of the Assistance of Art afterwards. And since *Nature* is the original Standard and Archetype of *Art*, there is no need of any thing else for the Information and Instruction of a good Physician how to proceed in this Case, but only to observe the measures of Nature, and how she obtains her End where she is not some way or other prevented, hinder'd, or obstructed in her Work.

Now to apply this: 'tis evident from what has been already observ'd concerning the Production and Formation of a Fever, that the first Principles and original Stamina of the Disease are laid upon the Stomach or Intestines; where a hot inflammatory Flatus being excited, the Business of Digestion is interrupted and perverted, and the due Separation of the grosser from the more fluid Parts of the Chyle prevented.

Now in this case the Business of Nature, or which is the same thing, the natural Consequence of such a State and Disposition, is,

I. THAT the muscular Coats, or nervous Fibres of the Stomach and Intestines, being urg'd by the Irritation and *Stimulus* of such heated, indigested, viscid, and rarefy'd Matter, are hereby brought into violent Action, or excited to very frequent and strong Contractions; by which means the indigested morbid Matter lodg'd in the first Passages, is thrown out of the Body by a natural Vomiting  
or

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or Purging, or both, according to the present State and Disposition of Nature.

2. DURING the *Luctus* and Struggle in the Stomach and Intestines, the Person by a certain loathing and reluctancy against solid Food, and all such Meats as require a considerable Time and Apparatus for Digestion, is forbid the use of them by the Voice and Law of Nature: for 'tis plain that while this great Gland, *i. e.* the Stomach, with its digestive Organs, and its excretory and secretory Ducts, the Intestines and Lacteals, are thus indispos'd, nothing that requires much digestion can be taken in without detriment; since all such things in this case must necessarily increase and heap up that Load of flatulent, viscid and indigested Matter, which Nature is now labouring to cast off. And in this primary Intention of preventing the first perfect Formation and Fixation of the Disease, the Circumspection and Diligence of Nature seldom fail her, unless the Weight and Resistance be too great at first, or she be otherwise injudiciously hinder'd and obstructed in her Work.

3. AND because while this is doing it must needs happen, that some part of the heated viscid Chyle must have made its way from the Stomach towards the Blood, so as to begin the Obstruction in the chyliiferous Ducts and the lymphatick Canals of the conservatory Glands; therefore Nature takes care, by the *Stimulus* of an uneasy Driness and Thirst, which is the natural Consequence of Heat and  
Rare-

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Rarefaction ; I say, Nature hereby takes care to command a timely abstinence from all heating fermenting Liquors, and instead of these to drink freely of such Liquors as are cooling, attenuating and diluting, without Fermentation. And by this means the chyloferous Ducts are wash'd and cleans'd, the Heat, Viscidity and Rarefaction in the first Passages suppress'd, the Digestion restor'd, and a free Passage made for the usual Drain and Circulation of the Lymph from the Arterys to the Veins.

AND thus the first Intention of Nature is obtain'd, a Crisis brought about, and the Solution of the Fever procur'd in the most safe and effectual way, before the Disease comes to be perfectly form'd, and fix'd on the whole animal System.

HAVING thus given the curative Intentions, and Method of Nature in this first Period of a Fever, I presume those who have a Genius of Medicine, and any acquaintance with it, will easily excuse me from being more particular. And indeed, he who cannot collect from this Corollary what ought to be done when occasion offers for the assisting of Nature in this case, is not fit to be a Physician, and would not be much the better, in all probability, for a larger Discourse about it.

### COROLLARY III.

FROM the foregoing account of the Production and Formation of Fevers, it may be observ'd of what mischievous Consequence it  
must

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must be in the full growth and perfect Formation of a Fever, to precipitate the Crisis or Solution by unseasonable injudicious Evacuations.

IF the perfect Formation of a Fever cannot be prevented, and the first Intention of Nature obtain'd, according to the last *Corollary*, but the Disease comes to form and fix itself upon the whole Animal Oeconomy, it will then have a certain stationary Period natural and peculiar to it: and this stationary Period is either employ'd by Nature, or ought to be employ'd by Art, in preparing and disposing the Blood and Humours for a regular Crisis.

IN this case Nature herself, if too hasty, ought to be restrain'd, as every Physician must be sensible, as often as he meets with any large symptomatical Evacuations, which are always attended with the worst Consequences, if not seasonably and judiciously prevented. And if this be constantly so, as all Experience testifies where the ante-critical Evacuations happen in a natural way, what can be said for the Practice of those, who as soon as ever they are sent for, without considering the Nature and State of the Fever, fall immediately to work by strong Emeticks, Catharticks and Sudorificks, to force off large Quantities of the Serum or thinner Parts of the Blood, while they should rather endeavour to increase it, and lay up as much as possible in store for a seasonable, natural, and salutary Crisis?

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WHEN a Fever is once thorowly form'd, the urging it to a Crisis before its natural time is procuring an Abortion, which in this case is always dangerous, and for the most part mortal. And the Reason of this is evident ; for since in this state of the Disease, where the Fever has fix'd itself upon the whole Mass of Blood, the heated, rarefy'd, viscid Serum is so closely united and intimately mix'd with the *Craffamentum*, that it cannot be separated without great Violence : and since in consequence of this, the communication of the Serum from the Arterys to the Veins thro' the Lymphaticks, must be in a manner intercepted and cut off, 'tis manifest that the forcing away the Serum thro' the expurgatory Glands, while the Blood is in this state, must leave the remaining part of the Mass still more hot and viscid, prevent a supply of cool diluting Serum from the Lymphaticks, and render the Canals impassable, and dispose the Glands to a Mortification, or Gangrene. In short, such a Proceeding cannot but be of very ill consequence, even tho Nature, as it sometimes falls out, should chance to be too strong both for the Disease and the Physician together. For hereby all the Symptoms will be aggravated, new ones induc'd, the Distemper protracted, and at last a very imperfect Crisis procur'd, which perhaps converts the Fever into some more chronick Disease ; such as a Scurvy of the worst kind, a *Phtbisis*, Dropsy, calculous Secretions and Petrifications, &c. by which

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the Patient is retriev'd only for a longer scene of Misery, and the case render'd more lingering, but not less dangerous. During this Period of the Disease, the Physician therefore is to attend with Patience, and carefully wait the farther Orders and Directions of Nature.

HOWEVER, in the mean while the Business of Dilution must be carefully and diligently manag'd ; for this is the proper time to cool and attenuate the viscid Humours, and to restrain and suppress the Rarefaction of the Blood : and this will be best done by convenient Drinks and in sufficient Quantities, assisted with the *Testacea*, Sal Prunel, vegetable and mineral Acids ; such as Juice of Lemons, Spirit of Sulphur, Spirit and Oil of Vitriol, &c. in Drinks and Juleps : still regarding with great Care and Attention the Habit, Custom, and Constitution of the Patient in his Health, as well as the present State and Symptoms of the Disease, to know what degrees of Cooling and Dilution may be most proper, and when and how far to moderate and restrain it.

By this Method a natural and regular Crisis may in due time be expected : the Serum of the Blood, which during the constituent State of the Fever had been over-heated, and closely and intimately mix'd with the *Crassamentum*, now comes to condense, separate, and pass off as usual by the several Secretions, both of the conservatory and expurgatory Glands ; which is, I think, what ought strictly and properly to be call'd the Crisis or Solution

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lution of a Fever. Now of this Crisis or Solution, the Signs, Symptoms, or sensible Appearances, are some or all of those which follow.

I. A SENSIBLE abatement of the Heat or Thirst, with a beginning Moistness and Lubrication of the salival Glands.

II. A PALER colour'd and a somewhat thick or muddy Urine, with a Sediment or Separation of its Parts upon standing.

III. AN easy, cooling, periodical *Diaphoresis*, or Sweat, which is at the same time pretty sensibly salt, viscid and fetid.

IV. VISCIOUS, tenacious and black, or otherwise discolour'd stinking Stools.

V. DISTINCT periodical Intermissions or Remissions, where the Fever was before continual, or with very irregular, imperfect, indistinct Intervals.

VI. A PRETTY equal, regular and natural Pulse, especially during the critical Discharges.

As soon as the Crisis or Solution of the Fever manifestly appears by these Symptoms, especially when the Intermision or Remission comes to be distinct, periodical and of any continuance, the Physician is presently and without loss of time to betake himself to that great and noble Antifebrifick, the Peruvian Bark, as the surest and most sacred Asylum in this Period of the Disease, and what may most rationally be depended on to secure a regular and salutary Crisis.

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AND this incomparable and divine Medicament may be so judiciously compounded and mix'd up into Juleps, Electuaries, Boles or Pouders, as to render it Solutive, Diaphoretick, or Diuretick, according to the principal critical Indication, or the particular Secretions or Passages by which Nature seems most dispos'd to throw off the morbid Matter.

AND here, since it may perhaps be of some use to younger and less experienc'd Physicians, I will set down my own Method of giving the Bark in Fevers.

IN the Intermiffion or Remiffion, when the foregoing Signs of Concoction or Solution appear, I order the following Pouder to be taken every three Hours, or at any time between the Fits, as the Intervals will permit, where there is not time for several Doses between any two successive Fits.

℞ *Cortic. Peruvian.* ʒ ss.  
*Coccineal. Rhabar.* aa ʒ i. *Misce. f. pulv.*  
*Divide in Chartulas, N° 12.*

IF this, as it sometimes happens, should have too great a Disposition to pass off downwards before it can make its due Impression upon the Blood and Humours, it may be conveniently alter'd thus :

℞ *Cortic. Peruvian.* ʒ ss.  
*Rad. Serpent. Virginian.* ʒ 2. *Misce.*  
*Divide in Chartulas, N° 12. ut prius.*  
 BUT

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BUT indeed sometimes the Bark itself will purge, and pass off too fast, as being too great a *Stimulus* and Astringent for some very weak and tender Constitutions; and in this case it will be most conveniently given in an Electuary with *Diascordium*, or the *Theriaca Andromachi*, after the following manner.

℞ *Theriac. Androm. Diasc.*  $\overline{aa}$  3 2 fs.  
*Cortic. Peruvian.* 3 fs.  
*Rad. Tormentil.* 3 2. *Misce.*  
 & cum *Syr. Cydon. q. s. fiat Electuar.*  
*sumat Q. N. M. tertiâ quaq; horâ.*

WHEN I find the Intermissions perfect, or the Remissions long and distinct, so as to discover the last evanescent State of the Fever, that I may cleanse and open all the Glands in general, especially those of the Kidneys, and secure a perfect Crisis, I give the Bark with the *Æthiops Mineral*, or *Cinnabar of Antimony*, or rather both together, thus:

℞ *Cortic. Peruvian.* 3 3.  
*Æthiop. Min. Cinnab. Ant.*  $\overline{aa}$  3 2.  
*Rhabar.* 3 1. *Misce. f. pulv.*  
*Divide in Chartulas, N° 12. sumat*  
*ter quaterve in die.*

OR, if the form of an Electuary pleases better, it may be thus directed:

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℞ *Conserv. Absinth. Roman.* ℥ 1.  
*Cinnab. Ant. Æthiop. Min.* aa ℥ 2.  
*Cortic. Peruvian.* ℥ 3. *Misce.*  
 & cum *Syr. è Chalyb. q. s. fiat Electuar.*  
*crassioris consistentiæ, sumat Q. N. M.*  
*ter quaterve die, ut prius.*

WHILE these are in use, if need be, a Purge or two may be given, and then the Person advis'd to take the free and open Air, and to set himself on some easy moderate Exercise.

### COROLLARY IV.

FROM this general Theory 'tis evident, that all Fevers are in some degree or other putrid; and that every true and natural Crisis, is a discharge and expulsion of that putrid or corrupt, stagnate and morbidick Matter.

FOR since in every Fever (as has been prov'd from the Nature and essential Characteristics of Fevers in general) the Separation of the Lymph or Serum from the Blood, both by the conservatory and expurgatory Glands, is in some measure intercepted, suspended and obstructed, during the Heat, Rarefaction and Viscidity of the Blood, and the strong Cohesion of the Serum with the *Crassamentum*: and since the Serum or Lymph both in the conservatory and expurgatory Canals must needs corrupt, putrefy, and contract a preternatural *Stimulus* and Acrimony, in proportion to the Diminution of its Motion and beginning Stagnation; and likewise in consequence of

of the Heat and Impetus of the distended turgid Blood-Vessels, with which the Lymphatics or excretory Canals and Emunctories of the Serum are compress'd and constipated in a Fever: 'tis manifest from hence, that a Putrefaction, Corruption, or preternatural Acrimony of the Serum in its proper Canals, must begin and proceed with the Fever, and will be proportional to the Nature and Quantity of the Obstruction.

'Tis true indeed that in Ephemeræ and Intermittents, where there is an entire Solution of the Fit after a short Period, this *Fætor*, Putrefaction, and Acrimony of the Sweats and critical Discharges, are not so apparent and sensible, as where the obstructed Matter is longer detain'd in greater Quantities, and wrought up to a more intense Solution and Corruption: tho' still the same Qualities may be observ'd in a lower degree, proportional to the Strength and Duration of the Fever, and the Quantity of the Obstruction.

AND from hence it plainly appears to be a great Mistake in those who derive this morbid Matter immediately from the Blood, at the very time of the Crisis; and suppose that the Blood during the state of the Fever has been fermenting like some spirituous Liquor, in order to throw off at last these putrid, corrupt, and acrimonious Recrements. But the Consequence of this Mistake is often fatal, when upon the Credit of such an Hypothesis, the Blood, even in the height and rage of Fevers,

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is still more heated and inflam'd with warm active Cordials, Alexipharmicks, inflammable Spirits, volatile Salts, and the like, under a pretence of fortifying the Heart, strengthening the Spirits, expelling Poison, and driving away Malignity.

THIS is blowing up the Disease, and putting Nature to the fiery Trial ; a short and sure way indeed to come to some end or other of the Matter, but a Method which the best practical Physicians, after the too great Cost of Experience, have now thrown up, tho many of them still retain the false Hypothesis upon which it was grounded.

SCHOLIUM I.

I AM sensible, upon such a Subject as this, how difficult 'tis to speak unexceptionably ; and therefore it may be proper, before I proceed farther, to obviate some Objections which may possibly be made against some part of what has been here advanc'd ; especially as to what has been offer'd under the third *Corollary* of this Proposition, against large Evacuations or Drains of Serum from the Blood, during the height and stationary Period of Fevers.

AND here it will perhaps be urg'd, that this is contrary to the approv'd establish'd Practice of very good and well-experienc'd Physicians, who in the strength and full growth of Fevers, very often draw off and cause a considerable Evacuation of the Serum, both by Blistering and Sudorificks as well as Catharticks.

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Now I own that every one may have observ'd this practice in Physicians, and I readily grant also that 'tis very often attended with Success, and that there may be a plain Reason and indispensable Necessity for it, under a judicious Management: but then I deny that the real Design or true Intention in this case is to draw off the Serum from the Mass of Blood, or to lessen its Quantity in general, which is the thing suppos'd in this Objection, for else it can be levell'd against nothing I have advanc'd. And that the true Intention of Blisters, Alexipharmicks and Sudorificks, when given or apply'd in this state of Fevers, is not to draw off the Serum from the Blood, or to lessen the Quantity of Serum in the Mass of Blood, is evident from hence; That the same Physicians at the same time, if they act rationally and know what they are doing, are always careful to enjoin free and plentiful drinking of such Liquors as are cooling, diluting, and without a Ferment; such as may most easily and speedily pass, and make their way to the Blood. This is of such consequence in the cure of Fevers, especially when they are come to their full Growth and Maturity, to prepare them for a good Crisis, that any other Method without it can be of little use.

Now this free and plentiful drinking and diluting, which all Experience testifies to be of the greatest Consequence in Fevers, is manifestly the nearest and most effectual way to

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increase the Serum of the Blood, or to augment its Quantity in proportion to the *Craffamentum* : and this is beyond all dispute the true Design of it ; the Reason and Necessity of which we have seen already.

BUT this increasing the Serum in Quantity, and cooling it in Quality, by Drinking or Dilution, must, according to the nature and import of this Objection, be contrary to the Physician's Intention, while he is lessening its Quantity, and heating it at the same time by the Force and *Stimulus* of Blisters, Alexipharmicks, and Sudorificks. But it cannot be imagin'd that any Man in his Wits, and much less a skilful Physician, should aim at such an Impossibility as heating and cooling, lessening and increasing the Serum at the same time: and therefore it may be of some Consequence here to shew the true Intention of this hot Method in Fevers, where it is judiciously us'd, and so as to obtain any real Advantage from it.

I. 'TIS well known, that very often in Fevers the principal Inflammation falls upon a particular Part ; in which case the Lymphaticks and glandular Canals belonging to the Part affected, being distended with a hot, viscid, acrid Serum, which cannot pass off by its usual Drains, the muscular Coats and nervous Filaments of the affected Parts will be heated, stimulated, and put into violent Action ; and in consequence of this, a greater Quantity than ordinary of the Blood will be  
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urg'd and deriv'd to the Part, which not being capable of passing off in the Course of its Circulation as fast as it is deriv'd, it must needs dilate and distend the Blood-Vessels; and being thus buoy'd up and pent back upon a particular Part, it must be put into a violent Fluctuation and intestine Motion, and become more hot and turgid: *i. e.* the Part thus affected will be tumefy'd and inflam'd. And this Inflammation of the Part will discover itself by the Sense of Weight and Oppression, attended with hot and burning, or with sharp, pungent, and acute Pains.

Now when this happens to be the case with respect to the Lungs, the Bronchia, the Pleura, the Tonfils, the Brain with its Meninges, or any particular Part from which a convenient Derivation or Drain may be directly made by Epispasticks or Vesicatorys; Blistering in all such cases will be of the greatest consequence, and soon discovers its good Effects, as all Experience testifies. For by this means the heated, stagnate, corrupt, and acrid Serum being drawn off, and the *Stimulus* and Irritation upon the nervous Coats and muscular Fibres remov'd, the Blood will have time to cool, condense, and take its usual Course; which will soon dispose the Fever to a natural and good Crisis or Solution.

BUT besides this more apparent and sensible Effect of those Vesicatorys just now taken notice of, there is another Consequence of the same Method, which must be equally beneficial

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ficial in the case before us, tho it is not so commonly observ'd, and it is this; That from the Heat and Rarefaction rais'd on the Surface by the potential Caustick or Epispastick, there must be a considerable Drain of the heated, rarefy'd, expanded Air contain'd in the Blood, and imprison'd or shut up in the internal, tumefy'd, inflam'd Part; which being the chief Cause of the Inflammation and Tumefaction, whilst retain'd in the viscid tenacious Blood or Serum, its being discharg'd must necessarily abate and take off the Heat and Intumescence. For the clearer understanding of which it must be observ'd,

1. THAT, as has been prov'd already, the Pores, and Interstices of the Blood and animal Liquors, as well as all other Fluids, are fill'd and replenish'd with elementary Fire and Air; which, by their conjunct and mutual Action upon each other, are the Causes of all Heat, intestine Motion, Tumescence, and Rarefaction in Bodys.

2. WHEN any glandulous and muscular Part or complicated Organ shall be irritated or stimulated in the manner before describ'd, and the Blood thereby deriv'd into it in too large Quantitys, so as to distend, tumefy and inflame the Part, 'tis manifest that an Obstruction must hence ensue; since in this case, only the thinner Parts of the Blood can be carry'd forward thro' the capillary Arterys into the Veins, while the thicker, more viscid, and tenacious Parts will be retain'd and accumulated,

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mulated, as being less capable of Motion. And the elastick Air being retain'd in great Quantities by this thick viscid Blood; and being hereby heated, rarefy'd, and put into a violent Commotion, while it cannot disengage itself from the tenacious Blood, it will be the chief Cause and Instrument of the Tumefaction and Inflammation.

3. 'Tis evident in fact, that the Surface of the Body is every where provided with absorbent Vessels, by which any external Applications to the Skin, provided they are subtile, thin, and fluid enough, are receiv'd and carry'd into the Blood; and which are of the same Nature with the Lacteals and absorbent Vessels in the Stomach and Intestines. This is plain in fact, from the Application of Plaisters, Ointments and Washes; the Matter of which has a free and easy Passage into the Blood, as the Effects testify: and 'tis impossible they should pass to the Blood thro' the excretory Ducts of the cutaneous Glands, without supposing two contrary Motions in those Canals at the same time. And therefore the Existence of these cutaneous absorbent Vessels, every where on the Surface, cannot be doubted of.

4. THE very active, subtile and pungent Salts therefore, with which the Cantharides in Epispasticks and Vesicatorys abound, having a free and easy Passage to the Blood, must upon the proper Application of a Vesicatory, soon make their way and mix themselves

selves with the viscid, thick, tenacious Blood, in the obstructed inflam'd Gland, Muscle, or other complicated Organ, which is suppos'd to lie directly under the Epispastick. And these Salts, by their Subtilty and Activity, must break, divide, and attenuate the viscid cohering Parts of the Blood, and thereby make way for the retain'd imprison'd Air to escape and fly off: especially when at the same time there is a way made for its Exit, by the Heat and Rarefaction on the Surface; and consequently the elastick Flatus must be impell'd thither, and pass off by the Vesicatory, where it finds the least Resistance.

Now from all this it is manifest, that the true Intention of Blistering in such cases, is not to drain off the Serum from the Mass of Blood in general, or to lessen the Quantity of Serum in general, and upon the whole; but only to derive and draw it off from some particular Part or principal Organ; where, by its too great Quantity and vicious Quality, it irritated and disorder'd the Parts, and occasion'd an Obstruction and Inflammation. But,

II. THERE is another general case, in which Blisters well manag'd may be, and very often are of great service; and that is in such Fevers as are commonly call'd Inward, Depressing, and Nervous.

THE common Symptoms of these Fevers are, a great Weight and Oppression in the Stomach and Abdomen; an inward, central, parching Heat; Cholick-Pains, melting, burning,

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ing, painful Diarrhæas ; very high-colour'd, and sometimes bloody Urine ; a weak, low, but quick, irregular and trembling Pulse ; great Laffitude and Weakness ; cold Sweats, Faintings and Convulsions ; with comatose Stupors, and a listless disregard of any thing that is said or done, from forgetfulness or loss of Memory.

Now from all these Symptoms, 'tis manifest that in such sort of Fevers, the Blood by some preternatural *Stimulus* is deriv'd in too great a Quantity and *Momentum* inwards upon the Stomach and Viscera ; and thrown with an unusual Impetus upon the several Bowels and Organs contain'd in the Abdomen ; while the Head, the Breast, and all the Parts supply'd from the ascending Trunk of the *Aorta*, are depriv'd of their due share and proportion of the vital Fluid : whence proceed the comatose Stupor, the small low Pulse, the external Cold, and all the rest of the Symptoms.

Now in such central or reflux Fevers, as I chuse to call them, from that particular Determination of the Blood which is the Cause of them ; Vesicatorys apply'd to the Head, Neck, Arms, &c. are often of great use to draw out the Fever, raise and diffuse the natural Heat, derive the Blood upwards, and outwards ; and thereby prevent the most fatal and dreaded Consequence which may otherwise be expected in such Cases ; that is, a Mortification of the Viscera. And for the same Reasons that Blistering is useful under  
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this Class of Fevers, moderately warm Cordials, Alexipharmicks, and Sudorificks may be likewise profitable, to derive the Heat outwards, and prevent a too great Surcharge of Blood and Humours upon the Stomach and Viscera; especially in a threatening symptomatical Diarrhæa, which it may be often necessary to check and restrain; and which Experience assures us may be best done by raising a gentle breathing Sweat.

BUT he, who observing the Use that good Physicians sometimes make of these heaters in Fevers, concludes from hence, that the Design of it is to force off the morbid Serum of the Blood, as if a Crisis might be procur'd or attempted at any time, is extremely mistaken: and whoever should proceed upon such a Supposition, would certainly do it very much to the Cost and Detriment of those who should be so unhappy as to fall under his Management.

IN the several Instances hitherto given of Evacuations artificially procur'd, before the Crisis or Solution of the Fever is expected, I suppose it must be evident, that the true Design of it is only to make such a Derivation or Revulsion of the Blood and Humours, as Nature shall indicate to prevent some worse Consequence: and indeed, all these Evacuations, which are sometimes artificially procur'd before the natural Crisis, are not made for the sake of the Evacuation itself, as properly critical; as if the time of the Crisis was in the  
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Physician's hands ; but only to prevent some greater and more dangerous, symptomatical, and preternatural Discharge or Evacuation, which must otherwise have happen'd.

BUT after all, notwithstanding the prudential use of Vesicatorys, hot Alexipharmicks and Sudorificks, in the Cases and for the Purposes hitherto recited ; yet in Fevers of another kind, which are commonly call'd Inflammatory, such as are attended with a high, strong, turbulent Pulse, great Strength, delirious Outrage, a burning external Heat, and especially where the Appearance of *Purples* on the Surface of the Skin, which are a sort of bloody Secretions, discover this diffus'd external Heat to be universal : in these cases, I say, and under such Symptoms, nothing can be more absurd or pernicious, than the Application of Blisters, or the Use of any heating, rarefying, attenuating Medicines. Nature itself will abhor any such Method ; and the fatal Consequences of it when rashly ventur'd on, will soon discover the Error, and proclaim aloud the Madness of the Physician.

#### SCHOLIUM II.

IT may be urg'd farther, that since a Plethora, or preternatural Fulness and Distension of the Blood-Vessels, must needs be the Consequence of a Diminution of the Secretions, and the increased Heat and Rarefaction of the Blood in Fevers ; therefore Evacuations must be proper, and necessary at any time, in order

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to take off the Plethora, which is a main Symptom and principal Part of the Disease.

BUT it ought to be observ'd here in the first place, that a Fever is not always attended with a Plethora, either as to its antecedent Occasions or consequent Effects: for it is well known that Fevers make their Onsets upon some too great and preternatural Evacuation, by which the Quantity of the circulating Fluid has been very much diminish'd; such as profuse Sweats, Diarrhæas, &c. And at the same time some symptomatical Secretion, or Discharge, may arise and proceed with the Fever; by which Diminution of the refluxing Mass in Quantity, the Fever is so far from being lessen'd or abated, that 'tis visibly increas'd and strengthen'd; as all Experience testifies, and every one in Practice must be sensible of.

AND as this proves that there may be a Fever without a Plethora in Quantity; so 'tis likewise evident from hence, that where the Plethora really exists, and is ever so evident in fact, we are not presently and at any time to attempt the lessening it by Evacuation, since we are so often oblig'd to check or restrain the precipitation and over-haste of Nature in this case, when any Secretions are unseasonably forc'd off, before the natural time of the Crisis; and which Secretions are well known to the Physicians under the Name of *Symptomatical*, which are always reckon'd as a Part of the complicated Disease.

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BUT the principal thing I would observe here, is, that the Plethora of the Blood-Vessels, occasion'd partly by the increased Quantity, and partly by the Heat and Rarefaction of the Mass; I say, this Plethora, which is indeed the general and most natural Consequence of a Fever, is likewise necessary to the Cure; as being a wise Provision made by Nature, to enable her to bear the expence of the approaching Crisis. For the Quantity of the corrupt putrefy'd Serum, which had been lodg'd in the Lymphaticks and glandular Canals during the Fever, and which must be wash'd out and thrown off in the Solution of the Fever, when the Blood comes to cool and condense, is oftentimes so very great, and the necessary supply of new Lymph from the Blood, at that time so considerable, that if there had not been a Plethora before in the Blood-Vessels, the Crisis must be inevitably mortal.

BUT for the clearer and more satisfying account of this, I shall here reduce it to a *Calculus*, such as the nature of the Thing is capable of.

IT appears then, from the Observations and Experiments which the learned and industrious Dr. *James Keil* has given us in his *Tentamina Medico-Physica*, that the Proportion of Fluids in an animal Body, is to that of the Solids, at least as 5 to 3; and consequently that in a Body weighing 160 Pounds, 100 Pounds of that Weight will be made up of Fluids. Now

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I shall suppose that a fourth part of this Fluid is contain'd in the Bones, Nerves, Cartilages, and solid Ligaments; which I presume must be allow'd as a sufficient Proportion, and of which, perhaps, there may be no great waste or diminution in a Fever. And this  $\frac{1}{4}$  of the whole, or 25 Pounds, being subtracted, there will remain 75 Pounds of the Fluid for the Blood-Vessels, Lymphaticks, and glandular Canals.

THE Proportion of the Lymphaticks and glandular Canals to that of the Blood-Vessels cannot easily be determin'd, and therefore an exact Computation cannot be here expected; but thus much is certain, that the Lymphaticks and draining Canals of the Serum, tho small, are yet exceeding numerous, and make up a very considerable part of the glandulous and muscular Flesh. This is manifest from the great Quantity of Serum, continually separated from the Blood, and thrown off by the several excretory Ducts of the Body; and which is not ordinarily less than five Pints or Pounds, in the space of 24 Hours: and likewise from the still greater Quantities of the Lymph or Serum continually drawn off and pour'd into the Blood again, to answer the Purposes of Attenuation, Comminution, Cooling and Dilution. I shall here suppose therefore, that the Quantity of Blood, or of the mix'd Mass contain'd in the Arterys and Veins, is to the Quantity of Lymph or Serum contain'd in the several *Tubuli* or *Receptacula* of the

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the Glands, as 4 to 1 : and consequently that where the Blood or mix'd Mass contain'd in the one, amounts to 60 Pounds, the Lymph or drain'd Serum contain'd in the other, will be 15 Pounds. Now 'tis evident that during the Flatus and Inflammation of the Fever, the greatest Heat and Rarefaction must be in the Blood, or mix'd Mass ; especially in the Arterys, where the Fluid has the greatest Velocity and Impetus. And from this Rarefaction and Repletion, dilating and distending the Blood-Vessels, 'tis plain that the Lymphaticks and draining Canals must be every where compress'd or constrain'd ; by which means the most fluid and subtile Parts of the Lymph and Serum, and such as are most capable of Motion, will be press'd and squeez'd out and carry'd off, either by some symptomatical Evacuations where these happen, or else by insensible Perspirations, during the Heat, *Luētus*, and Commotion of a Fever.

Now if from the Constriction of the Lymphaticks, a third part of the Lymph or Serum contain'd in these constipated Canals be suppos'd to be forc'd out and carry'd off, *i. e.* 5 Pounds where the whole Quantity is 15 Pounds ; 'tis plain that at the Crisis, when the Blood comes to cool and condense, the Blood-Vessels to contract, and the Lymphaticks to enlarge and distend as before, the drain'd Serum taking its usual Course, will pass thro' the Glands into the Lymphaticks and secretory Canals, now at liberty to receive it, in

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order to supply what had been forc'd out and carry'd off during their state of Constipation and Contraction: which will be the same thing in effect as if, the distended Blood-Vessels and constring'd Lymphaticks remaining *in statu quo*, 5 Pounds of Blood had been taken off at once, or in a very short time. And as a considerable Depletion of the Blood-Vessels must ensue upon the Crisis, or Solution of a Fever from the Cause just now mention'd, it may be observ'd farther, that the corrupt Lymph or serous Recrements, which during the Fever had been detain'd and pent up in those compress'd constipated Canals, being now wash'd out by a fresh and free supply of new-drawn Serum from the Blood; and being unfit to be retain'd in the Mass, and uncapable of subserving the several Offices and Functions of Life, must therefore be thrown off thro' the proper excretory Ducts and Outlets of the Body, in critical Discharges, during the time of the Crisis; and these critical Evacuations being made in a greater Quantity and Proportion than can possibly be supply'd again in the same time, must still more and more empty the Blood-Vessels, and occasion a greater Depletion.

BUT besides the two last mention'd, there is another Cause of Depletion, upon the Crisis or Solution of a Fever; and that is, from the Condensation of the Blood, which having been very much heated and rarefy'd during the Flatus and Fluctuation of the Fever, when  
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that Heat and Rarefaction ceases, as in the Crisis, the Blood will recover its former closer Texture and Cohesion of Parts; by which means the same Quantity will be contain'd in a less Space. And this will be the same thing in effect, as if the Rarefaction and specifick Gravity remaining as before, a certain Quantity of the Fluid had been taken off; such as is proportional to the previous febrifick Fermentation, and the consequent critical Condensation.

THESE necessary and natural Causes of Evacuation and Depletion upon the Crisis of a Fever, may, I suppose, be sufficient to shew that the antecedent febrifick Plethora of the Blood-Vessels, within certain Bounds and Limits, tho it be the Consequence of a Fever, is yet necessary to the Cure; and is owing to the Forecast of wise and provident Nature, in laying up a Store against a time of need, that may enable her to bear the Disbursements and Expences of a future Crisis.

A FARTHER very considerable Proof and Confirmation of this, may be drawn from the Conduct of Nature in those Fevers which take their Rise from the different Causes and Occasions of Depletion and Repletion.

ALL Experience assures us, that when a Fever is brought on by Over-fasting, Watching, violent Exercise, loss of Blood, or any too large Expences of the vital Fluids; or when in the State of a Fever, any great Depletion is occasion'd by symptomatical Evacuations,

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cuations, the Fever is hereby protracted: that is, the stationary Period, or the time between the perfect Formation and the Crisis, is lengthned out, and the Fever becomes slow and lingring, in proportion to the antecedent Depletion: the Reason of which is plainly this, That after such Depletions, it must require a longer time for the detaining and locking up the expurgatory Secretions, and for deriving sufficient Supplies, from Liquids taken in before the Blood-Vessels can be sufficiently replenish'd, the Serum of the Mass increas'd, diluted, and disengag'd from the *Craffamentum*, and Matters prepar'd for a safe and salutary Crisis, according to the Principles already laid down.

ON the other hand, when a Fever invades from any Causes or Occasions of Repletion, it will be more short and acute; and if the Tide rises not beyond the Bounds and Strength of Nature, a safe and good Crisis may be expected: but if it be likely to do so, it is the Physician's Business in that case, and in that case only, to check and restrain it, so far as to keep it within its natural and due Limits, by seasonable and effectual Evacuations.

N o w from all this it must, I presume, appear how much they are mistaken, who think the Cure of Fevers consists chiefly in Depletion and Evacuations, and who set about this Work at any time, in every state of the Fever, and without considering the Conduct of Nature. And indeed, it is a thing of the  
greatest

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greatest Consequence, carefully to observe and trace the several Steps and Gradations of Nature, under any particular sort of Fever, in those who recover of it without the assistance of Art. And this I shall venture to say, That no Physician can stand upon good ground, as to the Method he is to take, or the Succours he is to afford in the Cure of any Fever, till he has diligently observ'd, and inform'd himself how Nature cures the same Fever, when she does the Work without help; or how she endeavours to do it when she calls for assistance. But the stationary Period of Fevers, or the time between the perfect Formation and the Crisis, being the nicest and most difficult Season of all, and in which, I think, the general Run of Physicians are apt to be a little too busy, I have been somewhat the more particular, I hope not altogether unadvisedly, or besides the Purpose, under this Scholium.

PROPOSITION XV.

*TO assign the most general and remarkable Specifications, Forces, and Appearances of Fevers.*

IT appears from what has been hitherto consider'd, that a preternatural Heat and Rarefaction of the Blood, attended with an inflammatory Dilatation of the Blood-Vessels, and a consequent Compressure and Obstipation of the Lymphaticks and glandular Strainers, are

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are in some degree or other the necessary Constituents of every Fever, with regard to its general Nature and essential Form.

Now 'tis evident, that according to the different Degree and Quantity of these general Causes, or rather essential Constituents of a Fever, there will be particular Fevers generated, of a higher or lower Rank or Degree, and whose Symptoms will be more or less numerous, grievous and threatening, in proportion to the degree of Force, and particular Determination of these general Causes. And therefore it would be plainly impossible, and the very Attempt perfectly chimerical, to reduce Fevers to any certain determinate Number, under their proper and specifick Names, so as to exclude any new Forms and Appearances, such as might give occasion for some other specifick Name. 'Tis manifest that from the different Degrees and Quantities of Rarefaction, Inflammation and Obstruction in Fevers, and the different irregular Flux, and Determination of the Blood and animal Fluids, in particular cases, innumerable Symptoms may arise, and some new ones every Day, which had not been observ'd before. But to dispute in this case, whether any such new Symptom or Appearance must be allow'd to constitute a new Species; or whether it ought not rather to be consider'd as an Irregularity, under some of the commonly known and establish'd classick Terms and general Sorts; this, I say, wou'd be to raise a Controversy about

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about Words only, which could be of no Use or Consequence at all towards the right understanding and knowledge of Things.

ALL that can be done here therefore, will be to shew in, or after what manner the different Texture and Cohesion of the Blood, and the different Quantity and Determination of its Motion, will produce different Forms and Appearances in Fevers. And having done this with regard to some of the most general and ruling Cases, I must leave others to apply the same Method of reasoning to particular Instances, as they meet with them in Practice; and then, according to their Fancy or Humour, they may from the new and different Symptoms or Appearances, either form new and distinct Species of Fevers, under new and distinct classical Names, continually without number; or else with me reduce them all to some few general Heads and first Principles, which I take to be the most natural and rational way.

'TIS well known, that the Blood consists of two very distinct and separate Parts; that is, the *Crassamentum* or *Cremor*, commonly call'd the Globules, and the Lymph or Serum: and that when the Blood is let out, and left to stand and cool in a Bason, the globular Parts which constitute the *Crassamentum*, will unite, cohere, and sink to the Bottom in a coagulated Mass, while the Serum remains on the Surface, purg'd and clear'd of its *Crassamentum*. And as it is evident from this Sub-

sidence,

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fidence, that the *Crassamentum* is more dense, or specifically heavier than the Serum; so the same thing has been likewise more fully prov'd, and farther confirm'd from many other Experiments, by the learned Dr. *Jurin*, Secretary to the Royal Society. And from hence it is evident, by a Principle or Law of Nature already establish'd, that these Globules, consisting of the densest Parts of the Blood, or such as contain most Matter in a given Space, must be endu'd with the strongest attractive Force; that is, the Globules, and the Parts of which they consist, will attract each other mutually, more strongly than they are attracted by the Serum, in which they are immers'd. And this is the Reason why the Globules, when the Blood is left to stand and cool, unite and cohere in larger Masses, and then sink to the Bottom in a Lump of *Coagulum*.

Now in a regular and healthful state of the animal Machine, these Globules, which compose the *Crassamentum*, are kept from uniting, and cohering in larger and denser Masses, chiefly from two Causes.

FIRST, from the expansive Force of the heated Air contain'd in them; and of which no physical part of Bodys, whether solid or fluid, is wholly free, as has been prov'd already. By which expansive or centrifugal Force of the Air, contain'd in the Pores and Interstices of the Blood-Globules, there is way made for some Portion of the Lymph or Se-  
rum

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rum to enter ; and the denser and more solid Particles of the Globules, are kept from coming every where to a Contact, and forming themselves into solid, and too strongly cohering and indissoluble Parts or Corpuscles, as they otherwise would do by the Power of Attraction.

AND then, as the expansive Force of the Air tempers and restrains the greater attractive Power of these Globules, and hinders them from uniting into too large and solid Masses, so the same Force acting uniformly thro'out the whole Mass, must put the Blood into a pretty strong intestine Motion ; which will keep the Globules equally dispers'd in the Serum, and retain the Mass in a due state of Fluxility : and in maintaining and keeping up this intestine Motion of the Parts of the Blood, not only the elastick Force of the Air contain'd in the Blood, but likewise the constant muscular Action of the Vessels and Solids very much contributes.

BUT secondly, there is another very powerful and effectual Cause, which keeps these Globules disunited, in very small Corpuscles or *Spherulæ*, and hinders them from running into larger and more compact Masses by their attractive Forces ; and that is, the continual straitning and squeezing of the Blood thro' the small capillary Arterys : which fine drawing Pipes or evanescent Arterys, are infinitely numerous, and make up by far the greatest Part of the muscular and glandulous Flesh.

Now

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Now as the Blood can only be suppos'd to pass these fine Strainers in a very subtile Steam or Vapour, the Diameters of the Blood-Globules will always be kept to the Size and Proportion of these extremely minute *Tubuli* ; by which means the Globules are attenuated, divided, and disunited : and then, before they can form themselves into too large *Spherulæ*, by their attractive Force, they will come to be strain'd and drawn off in the same manner again, as they return to the Capillarys in the Course of the Circulation, and so on, as far as Nature acts regularly.

THE Globules, or small Particles which compose the *Crassamentum*, being thus attenuated and divided, and kept to a Size and Proportion capable of passing the small evanescent Arterys into the Veins ; the glandular Pipes and Strainers, which are still smaller, will admit only of the Lymph or Serum, which is the most fluid and subtile part of the Blood, and of which the several Secretions are made.

HAVING thus shewn the state of the case in a regular Constitution, and where there is no Disease or disturb'd Motion ; we may now carry the Matter a little farther, and consider what will be the Consequence, upon any distemper'd Heat and Rarefaction of the Blood, beyond the due Bounds and Measures of Nature.

Now 'tis evident that upon any increased Heat and Rarefaction of the Blood, the Globules,

bules, of which the *Crassamentum* consists, must swell, dilate, and enlarge their Dimensions; and being thus expanded and enlarg'd in bulk, they will imbibe and retain the thinner and more fluid Parts of the Lymph or Serum: but the thinner Parts of the Serum being thus absorb'd, and retain'd in enlarg'd and expanded Globules, the remaining Part of the Lymph must necessarily be the more thick and viscid; which Viscidity must be increas'd, in proportion to the increased Heat and Rarefaction of the Blood; as is manifest by putting any Portion of the Serum over a Fire, and exposing it to a moderate degree of Heat, somewhat beyond the natural Heat of the Blood; by which means, the greater part of the Serum will be visibly thicken'd, and turn'd into a sort of viscid tenacious Gelly.

Now the thinner Parts of the Serum being thus taken up by the expanded Globules, and the Viscidity of the Remainder increas'd by the Heat and Rarefaction, 'tis plain that the Drain of Lymph thro' the Glands will be diminish'd; and the distended Blood-Vessels, pressing at the same time upon the Glands, the Lymphatics and glandular Canals will be constipated and obstructed, more or less, according to the different Force and Degree of the obstructing Causes. And since in this case the enlarged Globules and viscid Serum will pass with more difficulty thro' the small capillary Arterys, these fine Tubes must be hereby dilated beyond their natural due Capacity;

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capacity ; which must excite the Sense of an hot, painful Distension or Tumefaction of the Vessels.

BUT farther, since a great many of the expanded Globules may become too large to pass the finer evanescent Arterys, they must necessarily be pent back, and oblig'd to pass those larger Vessels, which being more open and capacious, will be dispos'd to receive them: and by this means the heated *Crassamentum* will be thrown in a greater Quantity and Proportion on some Parts than on others, which must break and destroy the *Æquilibrium* of the circulating Blood ; and this will produce a sensible *Luētus* and Perturbation of Motion, an unequal Pulse, and variously mix'd, and irregular Degrees of Heat and Cold, with several other of the common Phænomena, and Symptoms of Rarefaction and Inflation.

BUT if we suppose the Heat and Impetus of the Blood, and the Force and Action of the Muscles to be carry'd farther, so as not only to expand and enlarge the Globules, but to break, dissolve, and divide them into the smallest Parts, and mix them so closely and intimately with the Serum, that they cannot be separated in the Secretions ; this must induce a most dismal and grievous train of Symptoms, such as are incident to Fevers of the highest rank and worst kind ; and which according to their Degree and Measure, or so far as they prevail, must quite subvert, and destroy the most necessary and essential Constitutions of the animal Kingdom.

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NOW if these Globules, which constitute the *Crassamentum*, are only broken, and divided to such a Degree as to increase the Rarefaction of the Blood, and Distension of the Vessels, but still to retain a bulk and size too large to enter the Lymphaticks and glandular Strainers; the consequence of this beginning Colliquation and Dissolution, will be a very great and extraordinary degree of Heat, Tumefaction and Inflammation, extreme Drought, burning Thirst, a very irregular Pulse, sometimes exceeding high, and at other times scarce sensible; violent Efforts and Outrage, with other Appearances of a like nature, consequent upon such a Degree of Heat and Rarefaction, too obvious to be here insisted on.

BUT if this Comminution and Division of the Blood-Globules proceeds farther, to such a perfect Solution and Colliquation of the *Crassamentum*, as to render it capable of passing the Lymphaticks and fine glandular *Tubuli*, the consequence of this will be bloody Secretions; a gradual Repletion of the Lymphaticks and glandular Canals with Blood; sudden Mortifications, Erosions, and Gangreens of the Flesh, with burning, caustick Swellings, and Tumours of the Glands and Tendons; and all those Symptoms which are the common and well-known Appearances and Indications of the highest Malignity, Inflammation, or pestilential Heat.

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THE better to understand this as the true state of the case in pestilential Fevers, let it be observ'd here, that Nature has taken all imaginable care, and made all possible Provision for retaining the *Crassamentum* in the Blood-Vessels, and to prevent its being separated and drain'd off, together with the Lymph or Serum, in the several Secretions ; and therefore as this never happens in ordinary cases, so whenever it does happen in any considerable Degree, the Danger is imminent, and it may be look'd upon as the Prelude and Forerunner of Death.

PHYSICIANS need not be told that this is so in fact, since all Experience testifies it, and every one of the least Observation must be sensible of it. And that it must be so from the Nature and Reason of the thing, will appear, if we consider the most distinguishing sensible Qualities of the *Crassamentum*, and how it differs from the Serum.

THAT the Globules, of which the *Crassamentum* is made up, consist of very small, dense, or solid Corpuscles, or Particles, with a small Portion of Lymph or Serum included, is certain in fact, and so commonly known, that there can be no need to insist on the Proof of it here. Now these Globules, consisting of the most dense, compact, and solid Parts of the Blood, 'tis evident they must be capable of receiving a greater Degree of Heat, and being once heated, they will retain their heat longer than any other parts of the Blood ; this  
being

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being the well known Property of dense and compact Bodys. And as the greatest Density must make these Globules the Subject of the greatest Degrees of Heat in the Blood, so it must give them the greatest Force of mutual Attraction and Cohesion; by which, in the ordinary and regular Course of Nature, they will form themselves into pretty large *Spherulæ*; which will hinder them from passing the Glands, and retain them in the Blood-Vessels, where alone they are capable of serving any of the Offices and Purposes of Animal Life. And therefore Nature has furnish'd the Blood-Vessels with very thick and strong Coats, and endu'd them with a considerable muscular Force, to enable them to bear the Heat, Impetus, and Resistance of these Globules; and to give them such a Degree of Motion and Agitation, as may be sufficient to keep them disjunct and separated, and hinder them from uniting, and running into larger and denser Masses.

AND as this shews the Reason and Necessity of retaining these hot and dense Globules in the Blood-Vessels, so it gives us at the same time an easy Solution of those fatal and mischievous Consequences which ensue, when in a preternatural and violent way they pass off in the Secretions, and come to be lodg'd in the Lymphaticks and glandular Canals.

THESE Lymphaticks and secretory Ducts of the Serum therefore, being provided but with very thin, soft, and tender Coats, or

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Membranes, as design'd only for the slow and easy Conveyance of a cool diluting Lymph; 'tis easy to imagine what will be the Consequence, when they come to be fill'd and obstructed with such a Substance as is that of the *Crassamentum*, or Blood-Globules. For these minute, dense, and elastick Globules, having been extremely heated in the Arterys, by the Rage and *Luētus* of the Fever, and being now drain'd off, and lodg'd in the Lymphaticks and secretory Ducts of the Glands, and there strongly compress'd and put into a violent intestine Motion, by the Dilatation and Distension of the Blood-Vessels, and not being able to move forward in the Course of Circulation; 'tis evident, that the soft and tender Coats of the Lymphaticks and secretory Ducts, will not be capable of resisting and sustaining the Force and Action of the Globules under these Circumstances; which would require all the Strength and Effort of the Arterys themselves. And consequently the Blood, having been thus heated and inflam'd in the Arterys, and then thrown out into such wrong Channels, it must prove corrosive and caustick to these fine, thin, and tender Tunicles. And this must induce Erosions, Mortifications, Gangreens, hot burning Tumors, purple, black, or livid Spots upon the Surface of the Skin; which are the corrupt, bloody Secretions of the cutaneous Glands, with the whole Train of dismal Symptoms, which are the too common and well-known Appearances of Malignity, or pestilential Inflammation.

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NOW in the first of these Gradations, where the Heat and Rarefaction of the Blood is such as only to swell and dilate the Globules, of which the *Crassamentum* consists, without breaking, dividing, and dissolving them; I call this a *Flatulent* Fever, as being the Effect only of Rarefaction and Inflation.

IN the second Gradation, where the Globules and Corpuscles of the *Crassamentum* are in great measure broken, comminuted and dissolv'd, so as to induce the more grievous and threatening Symptoms, which follow from a greater degree of Heat and Rarefaction, and a greater and more general Obstruction of the Glands, I chuse to call this Constitution and State of the Blood, a *Colliquative* Fever.

BUT where there is such a general and perfect Solution of the *Crassamentum*, as to produce bloody Secretions, Erosions, Gangreens, hot burning Tumors, &c. I shall give this Constitution the Name or Denomination of a *Cautick*, Malignant, or Pestilential Fever.

ANOTHER general ground or principle of Distinction and Division in Fevers, arises from the different Determination of the Blood in the Course of its Circulation, with respect to its Afflux and Reflex to and from the Head, and extreme Parts or Surface of the Body.

THE Blood in Fevers is sometimes thrown violently upwards and outwards, or deriv'd in too great a Quantity and Proportion to the Head and extreme Parts; which appears in delirious Ravings, great Strength, an high

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Pulse, and a burning Heat of the Flesh and extreme Parts; and at other times it is thrown downwards and inward, thro' the descending Trunk of the *Aorta*; while the Head and extreme Parts are depriv'd of their due Share and Proportion of Blood, and left cold and languid, with a weak low Pulse, loss of Strength, comatose Dotings, and frequent Twitchings and Convulsions of the Parts: that is, the *Æquilibrium* of the Blood in Fevers is broken, interrupted, and disturb'd in the Course of its Circulation; and this happens by its being thrown in too great a Quantity and Proportion, either thro' the ascending or descending Trunk of the *Aorta*. Now the first of these general Constitutions, or Perturbations of Motion, I call an *Effluent*, and the other an *Influent* Fever.

Now it is evident, that of the five Febrifick Constitutions, the two latter may be variously mix'd and complicated with the three former. For a Flatulent, Colliquative, or Caustick Fever, may either of them be Effluent or Reffluent: that is, the particular, febrifick Disposition, as to its main Force and Efficacy, may be either thrown outward upon the Flesh and extreme Parts, or inward upon the Stomach, Intestines, and the several Bowels and complicate Organs contain'd in the Abdomen; and from hence there will arise six compound, or complicate Constitutions, namely, the *Efflatulent* and *Inflatulent*, the *Effcolliquative* and *Influcolliquative*, and the *Efffluent*

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*fluent* and *Influent*, *Caustick*, Malignant, or Pestilential Fever.

HAVING here deriv'd these several sorts of Fevers from that real, internal Disposition of the Blood, and State of the animal Machine, and from that peculiar Perturbation of Motion, which forms this or that particular febrifick Constitution, and is the proper Ground or Origin of all the Symptoms, or sensible Appearances; I have been oblig'd to adopt some few Names or Denominations, which had not been thus us'd or apply'd before: and this I found myself under a sort of Necessity to do, as not knowing otherwise how to express clearly and intelligibly what I aim'd at. But if any one should reckon this Innovation a Fault, he will be at liberty to make use of any other Terms, such as may be more proper and less exceptionable, if he can find them: for provided the Nature and Reason of the Thing be duly kept by and regarded, I should not be at all dispos'd to quarrel with any body about Words.

It may not be amiss perhaps here, to take a little notice of some common Denominations of Fevers, which are taken from the Parts chiefly affected. For where the Fever is most remarkably thrown upon some principal, complex Organ, whose Office and Function is absolutely necessary to Life, that Organ is consider'd as the primary Seat, and *Fomes* of the Disease; and the Fever receives its Name from it accordingly: thus a *Peripneumony* is deno-

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minated from an Inflammation of the Lungs, a *Pleurisy* from an Inflammation of the Pleura, &c.

BUT as these Fevers are only for the most part particular Symptoms, and Appearances of some more general febrifick Constitution, to which they ought to be refer'd, and without which they can neither be understood nor cur'd; there is no need to enlarge upon them here. This, however, may be worth observing, and which I can pronounce upon Experience, that either in a Peripneumony or Pleurisy, the common fam'd Bronchials and celebrated Pectorals are of little or no use, how much soever they may be cry'd up and depended on. But a Derivation by Blisters, and moderate Catharticks, under a judicious Management seldom fail; and particularly in a Pleurisy, a large Blister apply'd to the pain'd Side, will give a more effectual and speedy Relief than any other Method whatever.

I KNOW the Generality of Physicians in this case fall directly upon Bleeding, in large Quantities, and repeated as occasion serves; and I must not deny that this Method is often successful. But I am well assur'd there can be no necessity for it, unless there be an Effluent Colliquative, or some plain Indications of effluent Malignity: but otherwise this Fever may be as well apply'd to, if not much better, without Bleeding than with it.

THE *Variolous* Fever, or that which attends the Small-Pox, is an Effluent of a peculiar

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liar Constitution: but with respect to the Texture and Cohesion of the Blood, or the different Proportions of the attractive and expansive Forces of the Blood-Globules, it is capable of any degree in that kind, and may be either a simple Flatulent, and a Colliquative, or sometimes even Caustick and Malignant. And upon this Gradation of the Fever, the Nature and Kind of the Pustles, as distinct or confluent, large or small, the Duration of the stationary Period from the Formation to the Crisis, and the whole Complex and Process of the Disease will intirely depend.

WHERE the Disease is attended only with a mild and moderate Efflatulent, as soon as the Irruption is finish'd, and the main of the Pustles have made their Appearance, the Fever ceases, or at least continues but in a very low and almost insensible degree. For in this case the Blood condensing, and the Globules of the *Crassamentum* recovering their natural attractive Force, the vitiated Serum will quickly and easily pass off by the excretory Ducts, and fill up the Pustles, which will be both large and distinct, and come to their Maturity about the eighth Day from the first Invasion of the Disease.

If the efflative Force of the Blood rises still higher, but without any thing of a Colliquation, the Irruption will be slower, the Fever continue longer, the Pustles, tho distinct, will be of a smaller size and more numerous, and the time of their Maturation pro-

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protracted to the eleventh or twelfth Day: and the Reason is plain; because in this case the morbid Serum, which ought to fill up the Pustles, cannot easily pass off and disengage itself from the adhering rarefy'd *Crassamentum*.

WHERE the effluent Force of the Blood is still increas'd, so as to run into Colliquations of the *Crassamentum*, and a stronger and more intimate Cohesion of the Globules with the Serum, the Pox will be of the Confluent kind; and according to the Strength and Degree of this Constitution, the Symptoms will be higher and more severe, the Fever protracted and continued, the Crisis deferr'd to the fifteenth, eighteenth, or even to the twenty-first Day, and perhaps sometimes longer; and the Disease will, in proportion to its Strength and Degree, put on all the Appearances of colliquative and malignant Fevers.

Now the Grounds and Reasons of all this, and from what Gradations of the internal Constitution the various gradual Symptoms and Appearances arise, is so evident from what has been already consider'd and explain'd, that to insist farther on this Matter, would be to suspect the Understanding of my Reader.

### C O R O L L A R Y.

FROM hence it appears, how exceeding hurtful and mischievous a Practice it must be, to give large and frequent Doses of Alexipharmicks, and hot rarefying Sudorificks, under a Pretence of driving out and keeping up the Pustles.

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Pustles; since 'tis manifest, from what has been said, that the too great Rarefaction of the Blood, and consequent too close and intimate Mixture and Cohesion of the *Crassamentum* with the Serum, is the main Cause that hinders, interrupts, or protracts the Secretions in this Disease, aggravates and heightens the Fever, and renders the Pox of the worst kind. All which being promoted and brought in by this heating Method, it is evidently destructive, and contrary to Nature.

AND from hence it likewise appears of how great consequence it must be in this Distemper, especially in the worst sort of it, for the Patient to drink plentifully all along of cool diluting Liquors; such as, considering the State of the Disease, and Custom and Constitution of the Person in his Health, the Physician shall judge most proper: since without this Provision, the Quantity and *Momentum* of the Blood will be so far lessen'd by the great Expence of Serum, in the mighty Load that is thrown upon the Surface of the Body, that there will not be a sufficient internal Force to carry on and complete the Discharge. And this is the true Method in this case to secure a good Crisis, and not that unnatural Flush, and false Appearance of Strength, which is given to the Blood by Alexipharmicks.

AN *Hætick* is a very slow, and gradually advancing Fever, attending the Scurvy, when that Disease fixes either upon the Lungs and Bronchia, or upon the Lymphaticks and chy-  
liferous

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liferous Ducts. The Hectick therefore is not a Fever originally and in itself, but symptomatically only, and in consequence of that Scorbutick Constitution, by which it is generated and form'd. Here then, to understand the Nature of an Hectick, it will be necessary to reflect a little upon the Scorbutick Constitution, of which the Hectick is properly a Symptom only.

Now in the Scurvy, contrary to what happens in Fevers, the *Crassamentum* of the Blood is condens'd, and the attractive Force of the Globules increased; and the Serum being vitiated, and render'd sharp and acrid, by the too great Quantity of Salts which it contains, is with such a Disposition discharg'd too fast, or thrown off by the several Secretions, in a greater Quantity and Proportion than what is just and natural. While the Lymphatics and glandular Canals are overcharg'd with a salt, acrid, corrosive Serum, the thinner Parts being thrown off, the thicker will be left behind, and form Nodes, Tumors, and eroding Concretions, which occasion an Ulceration of the Glands, and produce the several Symptoms of a Scurvy.

Now the Scurvy once form'd, and having fix'd itself upon some of the principal Glands, and necessary Organs of Life, generates an Hectick after this manner. The Serum and thinner Parts of the Blood being carry'd off continually, in larger Quantities than ordinary, the *Crassamentum* in proportion to the  
Serum

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Serum must still increase: but the *Crassamentum*, or Globules, being the hottest part of the Blood, as this increases in proportion to the Decrease of the diluting Serum, the Heat must likewise increase; that is, a Fever must be rais'd, and the Erosion and Ulceration of the Glands, especially when this Erosion falls upon the Lungs, thro' which the whole Mass of Blood is oblig'd to pass, it must still increase the Heat, while it hastens and promotes the Discharge of the remaining Parts of the Serum. Till at length the fluid Stores of Nature being exhausted, the principal Organs eroded, and ulcerated, and the solid, elastick, nervous Fibres parch'd, exsiccated, and render'd too stiff, tense, and unfit for Motion, a sort of old Age is induc'd, tho in the midst of Youth; and the Person dies enfeebled, emaciated, and in a manner scorch'd and dry'd up.

Now from this short Theory, the chief Intentions of Cure in an Hectick are plainly these.

I. To cleanse, unite and heat the eroded Glands and excretory Ducts.

II. To carry off the saline Recrement of the Blood, especially thro' the Kidneys, which are their principal Outlets and proper Strainers.

III. To qualify and mitigate the intemperate feverish Heat.

IV. To

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IV. To replenish the exhausted Vessels with a sufficient Quantity of wholesom Chyle, and proper Nourishment.

V. To strengthen and confirm the Habit by proper Exercise, and a right Use of the Nonnaturals.

WITH respect to the two first of these Intentions, which ought likewise to be primarily and chiefly regarded in Practice, I shall take leave to observe here, that amidst all the numerous Train of simple and compound Remedies, so highly cry'd up, and so much recommended by the several practical Writers, under the Name and Notion of Antiscorbuticks, there are none which can in the least be compar'd with some of the Mercurial and Antimonial Preparations; especially the *Æthiops*, *Cinnabar*, *Diaphoretick Antimony*, and the *Antibecticum Poterii*. And he who shall go about to cure a Hectick without a primary and chief Regard to the Scurvy, of which it is a Symptom, will find himself unhappily mistaken, to the great Loss and Detriment of his Patient. And from hence we may easily account for the general unsuccessfulness of those, who in the Cure of an Hectick, fall directly upon the Use of astringent Balsamicks, and agglutinating Mucilages, which serve only to clog the Viscera, thicken the Blood, and fix the corrupt Serum upon the eroded enfeebled Glands; while the case plainly requires, and Nature loudly calls for such

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such a powerful Deobstruent, and wonderful Sweetner, as that of Mercury. But as for those who will still obstinately persist in their old heating way, I shall only beg them to consult the Surgeons.

BUT it will be necessary here to consider a little more distinctly the Formation and different Appearances of such secondary, symptomatick, or glandular Fevers, of which the Hectick is only a particular Sort or Species: for as these Fevers are generated from either the hydropick or scorbutick State and Disposition of the Blood, 'tis manifest they will be of different kinds, and either Acute or Chronick, according to the different Degree and Measure of the general Constitution from which they proceed, and the various Parts or Organs chiefly affected.

AFTER what manner the morbidick Heat and Rarefaction of the Blood, enlarges the Blood-Globules, imbibes and retains the Serum, and diminishes or interrupts the glandular Secretions, has been shew'd already; and the several Species and Appearances of original legitimate Fevers from thence deduced: but 'tis plain that any sudden Condensation of the Blood by Cold, increasing the attractive Powers of the Globules, as the Force and Action of the expansive Elements are diminish'd, must have a contrary Effect, and dispose the Serum to pass off faster and quicker than ordinary thro' the glandular secretory Ducts, or straining Pipes; from which too quick

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quick and large Secretion, there must ensue a Surcharge of the secreted Matter upon the glandular Lymphaticks and Aqueducts, occasioning a painful Distension and Tumefaction of the Glands thus affected: in which case, the too quick and large Secretion from the over-cool'd condens'd Blood continuing, while only the thinner and more fluid Parts of the Secretion pass off, the grosser and thicker Parts of the Lymph or Serum will lodge upon the distended dilated Vessels, and increase the Inflammation and Tumor, till the obstructing Matter be either dissipated and carried off by proper Discutients, or brought to a Suppuration, and discharged by an Abscess.

Now from the general Cause here assign'd, 'tis evident that various sorts of Fevers may arise with different Appearances, which will be properly symptomatical of such Inflammations and Tumors of the Glands, tho the Blood be not otherwise at all over-heated and rarefy'd, but on the contrary chill'd and condens'd; and tho the other Secretions continue regular, and in their natural State. All which Fevers generally pass among the Vulgar under the common Name of *Colds*; and that not very improperly, since an irregular unequal Condensation of the Blood by Cold, is certainly the common Cause of them all: tho they will be of various sorts, Acute or Chronick, Effluent or Influent; and attended with different Phenomena or Symptoms, according to the different Degree of the Condensation, Distension, and

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and Inflammation ; the different Parts or Organs principally affected, and the different Habit or Constitution of the Patient.

THE antecedent Causes or Occasions of this morbidick Constitution, are chiefly such as these ; viz. a cold, damp, piercing Air, in which the nitrous Salts being minutely dissolv'd and diffus'd, pass together with the Humidities of the Air into the Blood.

SITTING or lying upon the Ground in a cold, shady, or moist Place ; especially while the Body is hot, and the Blood rarefy'd with Exercise, or the Heat of the Season.

DRINKING too freely of cold Small Beer, or Water, in a hot, rarefy'd, and sweating State and Disposition of the Blood ; and resting after it, or neglecting to keep up the Heat and Efflatus of the Blood, till the condensing Power of the cold Liquor be subdu'd and carry'd off.

THE too large and liberal eating of any sharp, raw, and unripe Fruits and cold Salads ; especially Cucumbers without their warmer Correctives.

THE going open with the Bosom, or exposing the Breast to a cold, damp, or foggy Air.

BUT above all, that general Constitution of the Air disposes to these Fevers, which is occasion'd by the sudden Fall of large and plentiful Rains, after a long hot and scorching Season : for here the Blood and animal Liquors having been very much rarefy'd, and raised to

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a high degree of Efflatus by the preceding Heats, are suddenly cool'd and condensed by the cold, moist, nitrous Air succeeding upon the Rains: by which means, great Quantities of hot sharp Serum being thrown upon the Glands, and there stagnating and corrupting, produce various sorts of inflammatory Tumors and Ulcerations. In which case they must expect to be the greatest Sufferers, who are of the most tender and delicate Constitutions; who clothe warm, keep for the most part within Doors, avoid Exercise, spend their Time in a continual Round of luxurious Idleness, and according to the common Phrase, *live well*; that is, to *no purpose*. For such good Livers having by Laziness and Luxury already clogg'd the glandular Organs and muscular Springs of Motion, with Loads of dull Phlegm, Flatulencys and Indigestions, when fresh Fuel comes to be added from any of the foregoing Occasions, they are presently torn to pieces; and the crazy lumpish useless Carcase is sacrific'd to the Destroyer without remedy.

THE Blood being thus suddenly condensed and its Serum thrown excessively upon the Glands, as the condensing Power of the Cold happens principally to affect sometimes one Part and sometimes another, a Fever will arise from the inflam'd, tumefy'd, eroded Glands, and discover itself by some of the following Symptoms.

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INFLAMMATIONS, Swellings, Abscesses about the Mouth, Face, Neck, and Throat; Hoarseness, violent Coughs, great Depression with a Sense of Weight upon the Breast, and Difficulty of Breathing: sometimes at first Vomitings and a Diarrhæa, which are soon follow'd with an obstinate Costiveness, and a hard tensive Tumefaction of the Belly; Cholick-Gripes, and Spasms of the Stomach and Intestines; a low, unequal, and tremulating Pulse; Coldness in the extreme Parts, and a livid Paleness of the Face and Skin; extreme Drowsiness, and comatose Stupor; a paralytick Deadness, and Relaxation chiefly on one side. After which, the Patient dies convulsed, and under a stupefy'd drowsy Raving.

ALL these Symptoms do not appear in all the Fevers of this glandular or condensative kind, but more or fewer, and with greater or less Severity, according to the Strength and Degree of the Condensation, the Parts affected, and the previous Habit or Disposition of the Body. Where the Distension and Tumefaction happens only upon the Parotid, Jugular or Maxillary Glands, the Fever is generally mild and benign; and easily carry'd off at first by Sweating, and a Blister upon the Neck: but if this has been omitted, as soon as the principal Tumor ripens and discharges itself outwardly, the Fever for the most part goes off, and all farther Danger is prevented by giving a Purge or two.

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BUT where the glandular Inflation or Tumefaction lies deeper in the Lungs or Breast, which may be known by the painful troublesome dry Cough, Depression of the Breast, and difficulty of Breathing; in this case, where the Tumor cannot be safely brought to an Abscess, and discharg'd outwardly, care must be taken to divert the Matter before it comes to an Abscess: to which purpose, the most effectual means is to apply without loss of time, a large strong Epispastick as near as may be to the Part affected; and at the same time to give, every three or four Hours, a small Dose of some proper Alexipharmick made gently opening. I have often found the following very efficacious, which therefore recommend for the sake of the less experienc'd.

℞ *Lapid. Contrayerv.* ʒ iii.  
*Rad. Serpent. Virg.* ʒ ii.  
*Rhab.* ʒ i. *Misce. fiat pulvis.*  
*Divide in Chartulas, N° 12.*

THIS may be made more or less opening as the case appears to be more or less inflammatory, either by leaving out the *Serpentari* and supplying the Composition with *Rhubarb* and *Sal Prunel* of each ʒ i ss. or by leaving out the *Rhubarb*, and putting the *Serpentari* in equal Quantity with the *Lapis Contrayerva*.

THE common Drink may be Mutton, Veal or Chicken Broth, Sack Whey, or Tea made

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with Sage and Buck-Bean, adding a little White Wine. But if the case be inflammatory, and attended with an effluent Heat, an high pulse and spitting of Blood, as it sometimes happens; equal Parts of Milk and Water mix'd together, and made into a thin Emulsion with the Pulp of roasted Apples, are extremely well adapted to the Intention, and as cooling opening Pectoral, are vastly preferable to all the more famous and celebrated Pectorals of the Shops, how much soever they may be admir'd and cry'd up in such cases.

BUT this morbid Constitution often lies yet deeper, and fixes chiefly upon the intestinal and mesenterick Glands; and then it discovers itself by an hard tense Tumefaction of the Abdomen, Cholick-Gripes, and Spasms, obstinate Costiveness, the sinking of the Pulse, the retiring of the natural Heat, and the most extreme Weakness and Languor, while the Patient is still sensible, and without much of a Coma or Delirium.

IN this case Epispasticks must be apply'd with all their Force, the stronger Alexipharmicks exhibited, Drinks impregnated with volatile oily Salts allow'd, with Opiates in sufficient Quantities: that is, all proper means must be used to take off the *Stimulus*, to raise the Pulse and natural Heat, to derive the Stream and Efflatus of the Blood outward, and thereby to prevent the too great and continued afflux of sharp vitiated Serum upon the intestinal and mesenterick Glands, which other-

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wife threatens a speedy Excoriation, Gangreen, Mortification, and Death. Where this Method in the present case has been too long neglected, all farther Attempts will be vain; for when the internal Mortification comes on, the strongest Epispasticks will have no Effect; but soon after they are taken off, the Flesh under them becomes pale, livid and dry, like the other Skin: upon which Appearance, after Blistering, the Physician may safely pronounce most certain Death, and that the End of the whole Tragedy is very near at hand.

PERHAPS it may not be amiss here, by way of Illustration, to give the History of a Greyhound, which having been exceedingly heated in a hard Course, presently took Water, and lap'd a considerable Quantity before he could be got out of the Pool: upon which he was immediately seiz'd with extreme Weakness, Faintness and Trembling, and with a total Obstruction in the Bowels, so that nothing could pass thro' him: and growing still worse, he soon expir'd under the most grievous Convulsions. Upon opening, the Stomach and all the other Parts contain'd in the Abdomen were found perfectly sound and good, excepting the Mesentery, which was exceedingly tumefy'd, and enlarg'd to four or five times its natural Bulk and Weight, and at the same time inflam'd and mortify'd: by the great Tumor and Distension of which, the Bowels were so constipated and compress'd, as to be render'd impervious and totally obstructed.

fructed. Now how this came about, is very evident from what has been said; for the Dog swimming into the cold Water, and taking it into his Stomach while he was thus hot and reeking, the Blood, which was extremely heated and rarefy'd, was hereupon suddenly chill'd and condens'd: by which a greater Quantity of the cool'd dissolv'd Serum was thrown in upon the mesenterick Glands than could possibly pass off again; which brought the Mesentery to that tumefy'd, inflam'd, and mortify'd State in which it was found, and which was plainly the Cause of all those grievous Symptoms that manifested the Injury the Creature had receiv'd.

THERE is yet a farther Degree of this glandular Inflation and Tumefaction, or quick and immoderate Afflux of the Serum upon the Glands and Lymphaticks; and that is, where the Inundation happens upon the cerebral Glands, and the Lympheducts of the Brain itself. In this case, the Drowsiness, Delirium, languid Restlessness, and paralytick Symptoms, increase in proportion to the Rise and Progress of the Obstruction, Inflation, and Tumefaction of the cerebral Glands and Lympheducts; till at last the Glands mortify, or the Lymphaticks break and let out a Deluge of Water upon the Brain, which renders the case altogether hopeless and desperate.

IN this hydrocephalick Fever, as I chuse to call it for the Reasons already assign'd, the only Method I have hitherto found to prevent

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the worst, and effect a Cure, is by applying a large strong Epispastick to the whole hinder part of the Head, so as to come up as far as the Crown, like a backward Cap or Coif. If this be done while the Patient is yet sensible, and before the comatose, delirious, and paralytick Symptoms appear, the Blister for the most part runs well, draws off great Quantities of serous Matter, and the Patients generally recover. But after the fore-mention'd Symptoms are come on, I have never found a Blister rise or produce any Effect, how large or forcible soever it may be made: and the Reason is, that when the cerebral Glands begin to mortify, and the Lymphaticks break, there ensues such a large Draught and Efflux of Lymph upon the Brain, that no Serum can by any Force be deriv'd outward, or drawn off by the Epispastick; and this I have found evidently confirm'd to Sense, and by Experience, upon Dissection.

THIS sort of Fever, or rather this degree of an acute glandular condensative Fever, generally comes on with Vomiting and Purging; as if Nature intended to relieve herself by that means: tho these Symptoms quickly disappear, and are succeeded by an obstinate Costiveness, and the Patient has no Stools but what are forced. I am therefore apt to believe, that an Emetick and Cathartick given immediately upon the first Attack might be of great service, but have never had an opportunity to make the Trial, as having never been call'd

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call'd soon enough in any such case. But this I know, that after the Fever has fix'd itself for a few Days, neither Vomiting, Purging, Bleeding nor Sweating, are of any use; but Blistering, especially on the Head, in the manner already mention'd, is the only Method that I have yet observ'd any the least apparent good Effect from.

BOTH these two last mention'd Species or Gradations of an acute condensative Fever, I mean the Hydrocephalick and the Hydromenterick, often meet together, and discover themselves in their different and respective Phænomena and Symptoms: and where this happens to be the case, their respective Methods of Cure must be comply'd with, and jointly pursu'd; which having been already consider'd distinctly, need not here be farther insisted on.

INTERMITTING Fevers or Agues, are a compound or mix'd Species, participating partly of the arterial rarefactive, and partly of the lymphatick condensative Kind: they generally attack People like glandular condensative Fevers upon taking Cold, and are especially fed and nourish'd by a cold, saline, damp, and fenny Air: they who are not used to such an Air, or to whom it is not natural and constitutional, upon going into it, and continuing in it for a time, seldom fail of catching these Intermittents; which are sometimes very obstinate, and terminate at last either in the hydropical or scorbutick Habit; and run into such

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such slow, lingring, and hectical Fevers of the glandular kind, as commonly attend those Constitutions.

AGUES, as every body knows, begin with a cold compressive Shivering, which lasting for about an Hour, sometimes more, sometimes less, is succeeded with an hot burning Fever, of the arterial and effluent kind. The Patient having been for several Hours scorch'd and tormented with this febrifick Paroxifm, he is at last perfectly reliev'd for the present by the Eruption of large critical Sweats, after which all the Symptoms disappear till the Fit returns in the same manner, either the next Day, or with the clear Intermiffion of one or two Days; from which variety in the periodical Returns, they receive the different Denominations of *Quotidian*, *Tertian*, and *Quartan* Agues. During the cold Fit, the Pulse is quick, small and low, in proportion to the depressing condensing Power of the Cold; but afterwards it rises and strengthens, proportional to the Strength and Violence of the consequent Fever. From the first attack the Person is affected with great Thirst, extreme Sicknefs at Stomach, Nauseas and Vomitings, which continue till the breaking out of the critical Sweats, and then are fufpended till the next Return of the Fit.

THESE Vomitings discharge considerable Quantitys of a cold indigested Slime, or viscid faline Gelly, which is more or less mix'd with Bile; as to which it must be observed, that

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that the bilious Vomitings in Agues, are the most salutiferous, and indicate the mildness of the Disease: but where the cold slimy Lentor, or viscid fix'd saline Gelly abounds, the Distemper is the more obstinate, and harder to be cur'd. And this is commonly the case in Autumnal Quartans, which are well known to be the worst and most inveterate of all Agues.

BLEEDING and Purging are of no Use, but for the most part extremely prejudicial in Agues; since they are found to weaken the Patient, and strengthen the Disease. Emetics given, that may have finish'd their Operation a little before the coming of the Fits, and Sudorificks toward the end of a Fit, to promote and help on the critical Sweats, are of great service; and by this means the Bark may be render'd effectual in the most obstinate Ague, and where the Disease would otherwise elude all the Physician's Care and Skill, and bid defiance to the Bark itself, as great a Remedy as it is.

Now from these Observations and Phænomena, may be naturally deduced the following Consequences, which may serve as Principles to explain the Formation, Growth, and various Appearances of intermitting Fevers.

I. THESE Intermittents owe their Origination and Production to a cold, saline, coagulated, and indigestible Lentor, generated in the Stomach by bad Air, cold, acid, and unripe Fruits, Meats of hard Digestion, and all such  
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Irregularitys in the use of the Non-naturals, as tend to promote the like sharp, salt, slimy Cruditys and Indigestion.

2. THE Stomach being once clogg'd and loaded with any considerable Quantity of this viscid, coagulated, and indigested Matter, still increasing from the Continuance of the same Causes; some Parts of it, by the natural Heat and Efflatus in the Stomach, the attenuating dissolving Power of the Bile mixt with it, and the Action of the muscular Coats still protruding it forward; from these Causes, I say, some Parts of the Lentor already describ'd, must be continually forced downwards, and pass together with a viscid and imperfectly digested Chyle, into the Lacteals and chyliferous Ducts: and from hence these Lacteals and chyliferous Ducts being gradually obstructed, dilated and distended, the Lymph which ought to pass continually thro' these Ducts into the Blood, will be now intercepted; and the Drain of Lymph from the Arterys into the Veins being thus interrupted, the Blood wanting this necessary means of cooling and diluting, must presently begin to heat and rarefy; that is, a Fever must ensue.

3. THE Blood heating and rarefying from the Cause here assign'd, its Velocity must at first be considerably abated, partly from the Over-fullness and Distension of the Vessels, occasion'd by the Rarefaction, and partly from the Resistance it meets with in the Gastrick, Epiploick, Intestinal, and Mesenterick Arterys:  
for

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for the chyliferous Ducts and Lymphaticks being now obstructed and distended, must necessarily press upon the capillary Arterys, in the foregoing Branches and Divisions of them. And while the progressive Motion of the rising rarefying Blood is thus check'd, retarded and diminish'd, there must from hence ensue a Sense of cold and chilly Streamings thro' all the Branchings and Ramifications of these obstructed Lymphaticks, chyliferous Ducts, and Blood-Vessels: that is, there will be a Fever, attended with Thirst, dryness of the Tongue, &c. from the Rarefaction of the Blood and the intercepted Lymph; and a cold Fit from the diminish'd Velocity of the Blood, and the sudden check it meets with in all those capillary Branches of the Arterys, which are now compress'd and constipated in the manner already mention'd.

4. THIS Obstruction of the Lymphaticks and chyliferous Ducts continuing, and consequently the Rarefaction and expansive Efflatus of the Blood increasing, it must press strongly upon the nervous Coats of the Arterys; and by the Force of such a *Stimulus*, the elastick nervous *Fibrillæ* being excited into quick and strong Vibrations, the Blood by this means overcoming the Resistance, is driven forward with a greater Force and Impetus than before; in consequence of which, the cold Fit must be follow'd with the hot burning febrile Paroxysm.

5. THE

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5. THE Heat and painful *Stimulus* of the turgid rarefy'd Blood, now acting upon the nervous and elastick *Fibrillæ* in the capillary Arterys and lymphatick Glands, the small Lymphaticks and chyliferous Ducts in the Glands must be hereby strongly squeez'd and compress'd, and their contain'd Chyle and Lymph forc'd out and driven forward: for while the viscid saline Coagulum which obstructed the Lacteals and Lymphaticks, is attenuated and dissolv'd, partly by the Heat and Rarefaction of the Blood, and partly by the Bile which it carry'd with it from the Intestines, and which is now excited into Action by the Heat; by this means, I say, the obstructing Matter being dissolv'd and attenuated, will be prepar'd and dispos'd to be dislodg'd, and driven forward thro' the chyliferous Ducts into the Blood, by the strong and forcible Action of the nervous elastick *Fibrillæ*.

6. THE chyliferous Ducts and Lymphaticks being thus clear'd and open'd, and the obstructing viscid Matter driven into the Blood, as a necessary Consequence of the hot Fit, in the manner just now explain'd; the Lymph will now flow freely and plentifully from the Arterys thro' the Lymphaticks and chyliferous Ducts into the Veins, as before; by which the Blood being cool'd, diluted and condensed, a plentiful Sweat breaks out, and the vitiated Lymph which had been stagnating in the Lymphaticks and chyliferous Ducts, now passes off in the Crisis by foul Sweat and

Urines?

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Urine: and this frees the Patient for the present, till the same Causes acting again after the same manner, the Fit returns, and every thing happens as before.

7. THE space of the Intermission or periodical Return, together with the Length and Severity of the Fit, will depend upon the Nature and Circumstances of the vitiated obstructing Chyle, or morbid viscid Coagulum, as generated in the Stomach: for where this is of a very cold, fix'd, and strongly cohering sort, abounding with nitrous and urinous Salts, mix'd with an extremely viscid or tenacious slime, it will pass more slowly from the Stomach and Intestines into the Lacteals; and being there, will be retain'd longer, and require more time and greater force to be driven out and dislodg'd: but where the vitiated indigested Matter is of a looser Cohesion, and abounds with Bile, and such-like warm and more active Principles, it will pass faster from the Stomach and Intestines to the Lacteals, and be more easily driven forward, when it has there produced an Obstruction or Dilatation, and rais'd a Fit; that is, both the Fits and their Intermissions will be shortned: and this is the difference with respect to their Rise and Progress, Generation and Growth, between Quartan and Tertian, or Quotidian Agues.

8. WHEN the viscid slimy saline Coagulum, with which the Lacteals and chyloferous Ducts have been obstructed and dilated, is perfectly clear'd off from the Glands, and thrown into the

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the Blood, by the contractive Power of the Nerves in the febrile Paroxysm; and afterwards discharg'd in the critical Evacuations by Sweat and Urine; a complete and perfect Intermision ensues, and all the Symptoms disappear till the next Return of the Fit. In which case, a certain Number of these Fits, by cleansing the Stomach, depurating the Serum, and throwing off the indigested Viscidities of the Chyle, relieves the obstructed Glands, completes the Purification of the Blood, and leaves the Person in a sound and perfect State of Health; and this by the Wisdom and Providence of Nature only, without any Aid or Assistance from Art and Medicine.

It may be proper therefore to observe here, that Spring Agues, by which the congested Viscidities collected in the preceding Winter, are frequently thrown off by the wise Provision and good Conduct of Nature itself; and which are not likely, by reason of the ensuing Heat of the Season, to sink the Blood into any great degree of Condensation; need not consequently be much tamper'd with by Medicine: and indeed, in this case, unless the Physician be very prudent, 'tis a thousand to one if he does not do more harm than good. For this I take to be a certain Rule, that where the Design of Nature is obvious, and the Intention right, she ought not to be too hastily interrupted, by a foolishly indulgent and over officious Care; and he who offers her his Service before 'tis needed, is in a fair way of making

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making work for himself, or for some body else that is wiser.

BUT Autumnal Agues, especially such as come on in *August* or *September*, upon a plentiful fall of Rains, after great preceding Heats and a scorching Season; and generally all Agues at any time of the Year attacking weak and languid People under scorbutick, hypochondriacal or hectical Habits, ought carefully to be observ'd, and taken off as soon as possible: for under any of these Circumstances, where the general Constitution of the Air, or the antecedent morbid State of the Person affected, conspire with the Disease, and tend to throw off the Serum plentifully upon the Glands and Lymphatics, which were too much clogg'd and loaded before, Nature will certainly want help; and they who in such cases are too secure, and trust themselves accordingly to the Conduct of Nature only, will soon be sensibly convinc'd of their Mistake: the reason of which different Event of Agues at the different Seasons of the Year, and under the different antecedent Constitutions of the Person affected, must be too plain from what has been said, to need any farther or more particular account of it.

9. EVERY body knows that Agues often lose their Intermissions or distinct Periods, and exchange their peculiar Symptoms and Appearances for those of continual Fevers, which are then generally, if not always of the influent, lymphatick, and condensative Kind:

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for

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for where the indigested Chyle and glandular Viscidities clear'd off into the Blood by the Paroxysm, or where the critical Sweats have not been large or lasting enough to eject and throw off the vitiated corrupt Serum, 'tis plain the Fever must hereby become continual, or remitting only; and Nature in this case having no leisure Hours, must be oblig'd to ply her Work incessantly, till such time as the Disease can be subdu'd.

BUT Agues of an ill sort, or such as have not been rightly manag'd, if they do not run into some acute continual Fever, very often leave a scorbutick Taint upon the Glands, and pass into some morbidick chronick Constitution equally dangerous, if not timely prevented. For all the hypochondriack and hysteric Maladys, the Gout, Stone, Dropfy, *Phtisis*, Asthma, and in general all the various Shapes and Appearances of the scorbutick Constitution, as described *Prop. 13.* may proceed from such a glutinous indigested Matter, according to the various Parts affected, or the particular glandular Organs upon which it is thrown and where it happens to be lodg'd and retain'd 'tis true, indeed, the same morbid State of the Chyle and Serum, will have the same Effect whether an Ague has preceded or not; which having been consider'd and explain'd already under *Prop. 13.* I need no longer insist on it here.

THE Method of Cure in Agues by the use of the Bark, is now so commonly known, and universally practis'd, that it would be needles

to repeat here what so many have already said about it: I shall content myself therefore, with only making some general Observations concerning the Nature and Operation of this celebrated Drug, so far as its Effects depend upon any of its manifest Property's or sensible Quality's; and beyond this it would be in vain to search, since the finest and most plausible Hypotheses can signify but very little, where they are not evidently built upon plain Facts.

THE Peruvian Bark, therefore, is most remarkably attenuating, absorbent, and astringent; which Property's it possesses under such an equal Degree and Contemperature of *Heat* and *Cold*, that it does not discover any prevalency of the one above the other: for tho' it may occasionally and consequentially, on the account of other Circumstances, as we shall see afterwards, produce the different and contrary Effects of heating and cooling, rarefying and condensing; yet in itself it is perfectly temperate with respect to those Quality's, and neither heats nor cools, rarefies nor condenses the Blood and Humours: that is, it does not act at all immediately and directly upon the expansive Elements of Fire and Air, but exerts its peculiar Power and Efficacy upon the gross Substances of Water, Oil, Salts, Earth, &c.

THE attenuating dissolving Power of the Bark, is evident from all the Experiments made upon it; and particularly a strong De-

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coction of it mix'd with Blood fresh drawn in a Porringer, will keep up its Fluidity, and prevent its Coagulation longer than any thing else hitherto known or discover'd ; and by the same means, the Serum is kept from coagulating in a much greater degree of Heat than would otherwise presently turn it into a Gelly.

THIS attenuating dissolving Power of the Bark, is plainly owing to the strong corpuscular Attraction of its Particles : from whence it comes about, that when it is convey'd to and mix'd with any viscid Coagula, or Concretions of the Chyle or Serum in the Stomach, Intestines, and glandular, chyliferous, and lymphatick Ducts, by attracting the small Parts of those viscid Concretions more strongly than they are attracted by each other ; the concreted cohering Parts of such viscid Coagulums, must necessarily be separated, dissolv'd, attenuated, and unite minutely and intimately with the Parts of the Bark, by which they are attracted and strongly retain'd : and consequently the dividing, dissolving, attenuating, and absorbing Propertys of the Cortex are plainly but different Effects from the same Cause, *viz.* the strong and potent corpuscular Attraction of its constituent Parts.

THE viscid Coagulums, and slimy salin Concretions of the Chyle, Lymph and Serum being thus attenuated, attracted, and retain'd by the Bark, the same wonderful Drug, by its constringing stimulating Power upon the ner-

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ous elastick *Fibrillæ* and muscular Coats of the Vessels, brings them to a strong and vigorous muscular Action; and by exciting and strengthening their contractive restitutive Forces, promotes and carries on the Protrusion and Expulsion of the morbid Matter, which had been antecedently dispos'd and prepar'd for Secretion and Expurgation, in the manner and by the means just now mention'd.

FROM this dissolving attenuating Power of the Bark upon the Fluids, join'd with its constringing stimulating Force upon the Solids, under an exact Adjustment and equal Temperature of Heat and Cold, all its Effects may be evidently explain'd and accounted for: and if any thing else could be found out, endued with the same manifest Propertys or sensible Qualitys, there can be no great doubt but it would have the same sensible Effects with the Bark itself. Indeed the same Constringency and *Stimulus* upon the Solids, even to a much greater degree, if requisite, might be obtain'd from many other things that are very well known; but the same dissolving attenuating Power upon the Chyle and Lymph, without over-heating and rarefying the Blood and Humours at the same time, cannot be effected by any thing hitherto known or discover'd besides the Bark: and herein, I think, plainly consists its peculiar Efficacy and distinguishing Characteristick in the cure of Fevers.

THE coagulated indigested Viscidities in the Stomach, Intestines, and chyliferous Ducts,

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being thus attenuated, attracted, retain'd and thrown off by the Bark, as aforesaid ; the natural Digestion hereby recover'd, and free Communication of the Chyle and Lymph from the Stomach and Arterys into the Veins restor'd ; the Fever hereupon ceases : and by this means the Bark becomes consequentially and in its Effects, a great and sovereign Cooler and Diluter of the Blood.

IN weak, low, and languid Constitutions, where the Appetite is lost, the Digestion vitiated and deprav'd, the Pulse sunk, and the natural Heat exceedingly diminish'd, from the Weakness of the Stomach and Intestines, the Relaxation of their Coats, and the Loss or Diminution of their muscular elastick Force ; the Bark is the greatest and most efficacious Stomachic in the World. In which case the Bark, by its attenuating dissolving Power upon the indigested Viscidities, and constringing Force upon the Solids, corrects and restores the Digestion, contracts, strengthens, and braces the muscular elastick Fibres ; and by sending a sufficient Quantity of well digested Chyle into the Blood, recovers the natural Heat, raises a low and languid Pulse, and strengthens, warms, enlivens and invigorates the whole animal Frame.

'TIS manifest from what has been said, that both these Effects of the Bark, in suppressing and sinking the natural Heat when it runs too high, and raising and recovering it when it retires, languishes, and sinks too low,

are consequential only, and owing to its attenuating, dissolving, and constringing Powers; while in itself it is neither sensibly heating nor cooling, but perfectly temperate with respect to these Qualitys. That the Bark has occasionally, and under different Circumstances, both these contrary Effects of heating and rarefying, cooling and condensing, every body knows; but that the same thing should be naturally, directly, and in itself, endu'd with such perfectly opposite and contrary Qualitys, is plainly impossible: and therefore where either of these Intentions come in view, beyond what can be obtain'd consequentialy from the Bark itself, in the manner already explain'd, we are oblig'd to render it more heating or cooling, by the due Composition and Mixture of other Ingredients, as the case requires. For instance; in the Intermissions or Remissions of low glandular and condensative Fevers, the Efficacy of the Bark is much rais'd and improv'd by *Virginian* Snake-root, Saffron, Cochineal, and such-like warm Alexipharmicks, which well-timed and proportion'd, will enable us to diffuse the natural Heat, bring out the critical Sweats, and procure a good Solution and Crisis; which otherwise could not be obtain'd by the Bark alone. But on the other hand, in the Intermissions or Remissions of Effluent, Inflammatory, and highly Rarefactive Fevers, the *Testacea*, fix'd Salts, and Acids, ought to be join'd with the Bark; or such cooling diluting Liquors im-

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pregnated with these, as may hasten the Condensation and Solution of the Blood, and bring on a timely Crisis; which otherwise might be too long protracted, to the great Hazard of the Patient, and Disreputation of the Physician.

T H E R E are two Inconveniencys upon contrary Extremes, which frequently attend the use of the Bark in different Constitutions: for in some it will purge, and run off so fast as to take no Effect; and in others it constipates and shuts up the Bowels, so as to hinder all natural Evacuation by Stool, and bring on an obstinate Costiveness. Both these Extremes may prove very prejudicial, and are therefore carefully to be guarded against in the use of the Bark. The Inconveniencys of an Over-Purgation in this case are commonly known, and accordingly provided against; but the Error on the other Extreme is not sufficiently adverted to, tho it is, at least, equally prejudicial, and for the most part of worse Consequence. For after the Bark has attenuated, attracted, and imbib'd as much of the indigestible coagulated Viscidities as it is capable of, it is certainly of no farther use to be retain'd in the Body, but requires a speedy Ejectment; which if it be not done by Nature, ought to be procur'd by Art: and by this means there will be way made for continual fresh Supplies of the same Medicine, till the remaining Parts of the indigested Lensor be attenuated, dissolv'd, imbib'd, and carry'd off  
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after the same manner. And indeed a Diarrhæa, which comes purely upon the use of the Bark, is not presently to be stop'd, but only to be check'd, restrain'd, and kept within some moderate bounds: and if nothing be done, such a Purgation generally goes off of itself in a day or two; or becomes so moderate as not to exceed two, three, or four Stools in 24 Hours; with which, tho it should continue, the repeated Doses of the Cortex at the usual Intervals will succeed very well, and throw off the Disease with greater Expedition and Safety than if there were a long continu'd Costiveness, or a Stool but once in two or three Days: nay, in all great Oppressions and hot inflammatory Inflammations of the Breast and Lungs, such a Discharge as this last mention'd ought to be procur'd, if need be, by adding Rhubarb to the Bark, or something of like nature, moderately cooling and opening; and if the Pulse be at the same time too low, the difficulty of Breathing great, and the Fever throws itself upon the glandular Organs of the Abdomen, the *Serpentaria*, *Contrayerva*, Saffron, or the like, may be added to the Bark, notwithstanding the Rhubarb and Openers: for tho these may seem to be contrary Intentions, yet they may very well be obtain'd together, as I have constantly found by Experience. And this Method of moderate Purg- ing, while a breathing Sweat is at the same time kept up by proper Alexipharmicks, is the surest and shortest way of proceeding in all

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all low, depressing, glandular, or condensative Fevers, where the Patient's strength will bear it, and the Disease is not highly contagious, or directly pestilential.

THE contrary Practice, I presume, has sometimes obtain'd, upon a wrong Hypothesis, that the Bark can never be too long retain'd in the Body, or be convey'd in too great Quantities thro' the Lacteals and chyloferous Ducts into the Blood : but whether this wonderful concoctive Dissolvent be of any use in the Blood or no, after it has spent its Force, and perform'd its attenuating, dissolving, and absorbing Offices in the first Passages ; or whether it has any such Power of attenuating, dissolving, and carrying off the Coagula, and viscid Concretions in the other Glands, or is capable of passing so far, may, at least, be very well doubted, if not clearly and positively deny'd. For my own part, I shall freely declare it as my Opinion, that the Bark exerts its chief, if not its sole Efficacy and Dominion in the great concoctive Gland : by which I understand the Stomach and Intestines, with their proper Secretorys, the Lacteals and chyloferous Ducts. For in the first place, after this Medicine has spent its force in the Stomach, Intestines, and chyloferous Ducts, by dissolving, attracting, and retaining as much of the indigested Viscidity as it is capable of, and is at last arrived into the Blood, there seems to be no use for it there, but to be thrown off by the natural Secre-

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Secretion of Sweat or Urine, together with those indigested viscid Impuritys which it had attracted and retain'd, and with which it had been clogg'd and saturated in its Passage; at least, it cannot be imagin'd, that a Substance so strongly attractive and retentive of Visciditys, when it has been thorowly sated with such as it must have attracted and imbib'd in the first Passages, should after this be dispos'd to enter the more remote Glands, so as to be capable of dissolving the congested Lentor and Visciditys there.

BESIDES, had the Bark any such attenuating, dissolving, and discussive Power upon the more remote Glands, as it is found to have upon the great concoctive Gland and first Passages, it must be capable of discussing and resolving the Tumors and viscid Secretions of the Bronchials, hepatick, splenick, pancreatick, and renal Glands; that is, it would be as general and effectual an Antiscorbutick, as it is an Antifebrifick: but Experience has never confirm'd any such use of it; and whoever makes the Trial with such an Intention, will find himself disappointed. That the Bark has a mighty Force and Efficacy in the primary digestive Glands, *viz.* the Stomach, Intestines, and chyliiferous Ducts, is very well known and sufficiently confirm'd by Experience; and this I take to be the natural Bounds and Limits of its Empire and Dominion, beyond which this great concoctive Dissolvent has little or no Effect: and indeed, it may be  
taken

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taken as a general and certain Rule in Practice, that things which exert their principal Efficacy upon the first Passages, ought not to be carry'd farther, or depended on in the more remote glandular Recesses ; but are to be prudentially thrown off with all convenient speed, by Stool, Sweat, or Urine. Whatever is intended to work upon the remote Glands, ought to be carefully guarded ; and its Force and Efficacy taken off upon the first Passages, by volatile oily Salts and Opiates, till it arrives at the principal Seat and proper Centre of its designed Agency : and this Intention might more effectually be obtain'd, by conveying the appropriated Medicines into the Blood, without passing them thro' the Stomach, Intestines, and chyliferous Ducts ; that is, by the means of Washes, Perfusions, Baths, and Unctions: a Practice much in use among the Antients, and still retain'd by the more barbarous Nations ; and for this Reason only, perhaps, left off, and thrown out in politer and more civiliz'd Countrys, where Physicians are more numerous, Ease and Luxury more abounding, and Health much scarcer and dearer. But whether this Method be likely to be approv'd or not, one thing I am sure of, that herein lies the great Secret of Alteratives, which by a more proper and significant Name might be call'd glandular Dissolvents, Cleansers and Catharticks.

BUT to return, after the Fits of an intermitting Fever have been put off by giving the

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the Bark in Substance, as usual, and its Ejection by Stool promoted, by keeping up the natural Evacuation at least once in 24 hours; the most sure and effectual way, is to drink the Infusion in White Wine twice a Day, Morning and Afternoon, for three Weeks together: and for the poorer sort of People, who cannot bear the Expence of White Wine, it may be infus'd in Cyder, or even in common Small or Table Beer. The Bark in its gross Substance being very cohering, and strongly attractive of its Parts one upon another, is not much adapted for Digestion and Chylification to pass into the Blood: and therefore the viscid Concretions and indigested Crudities of the Stomach and Intestines, having been first attenuated, attracted and ejected, the finer and subtiler Parts of it will much more easily pass the Lacteals and chyloferous Ducts, together with the fluid Menstruum in which it is dissolv'd: by which means, the remaining Viscidities lodged in these Lacteals and chyloferous Ducts, will be dissolved, attracted, and wash'd out into the Blood, and afterwards thrown off by the critical Discharges; and hereby the Return of the Fits in Intermittents will be much better prevented, than by continuing the Bark in Substance, or giving it in gross at the Interval of seven or eight Days, as any one will find upon Trial.

EXPERIENCE has taught us not to give the Bark in a febrile Paroxysm; and every body knows that when it is thus given, the  
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Fit will be thereby protracted and strengthened; which in highly inflammatory and rarefactive Fevers especially, is very dangerous; the Reason of which is, that while the Stomach is extremely heated, and the Air contain'd in it forcibly rarefy'd, every thing admitted into it must presently rarefy and run into a *Flatus*, by the expansive Force of the heated rarefy'd Air. But the Bark being strongly constringing and stimulating, when it is thus over-heated and rarefy'd in the Stomach and first Passages, must forcibly vellicate the nervous Coats and elastick *Fibrillæ*, and render their Action more intense and strong; and this must raise the Heat, and increase the Rarefaction and Efflatus of the Blood and Humours, which were too high and intense before: and besides, while the Bark is in this hot, rarefy'd, flatulent State it cannot attract, absorb, and retain the febrile Viscidities, and indigested Lentor of the first Passages, as being resisted by the contrary Action of the expansive Elements; and therefore under such Circumstances it cannot perform its proper Action, and consequently can do no good, but must necessarily do hurt.

THE Bark being the principal Remedy now in use for the Cure of Fevers, and perhaps the best that can ever be expected, I have made these practical Observations concerning it, not for the *Adepti*, from whom I shall be always ready to receive Instruction, but for the sake of younger and less experienc'd Physicians; that understanding its true and proper Operation

and Efficacy, and what may or may not be expected from it, they might form their Judgments of it, and direct their Practice upon it accordingly.

S C H O L I U M I.

FROM the foregoing Theory of Fevers, it may be proper to observe here, the mutual Relation, Connexion, and frequent Reciprocation, between the arterial, rarefactive, and lymphatick glandular Kind; for by shifting the Scene from one to the other, Nature frequently endeavours to relieve herself under the contrary extremes, and to gain a breathing time by the alternate Rarefactions and Condensations of the vital Fluid; till the Blood can be restor'd to its natural State, and settled in its original salutary Constitution.

ANY occasional inflammatory Heat and Rarefaction raised in the Blood, however brought on, must, by thickning the Serum, expanding and enlarging the Blood-Globules, and closely uniting the *Crassamentum* with the Lymph, diminish and interrupt the glandular Secretions; and this cooling diluting drain of Lymph from the Arterys into the Veins, being obstructed and intercepted, the Heat and Rarefaction of the Blood must still increase, till the Blood-Vessels having acquir'd a Plethora and immoderate Fullness, partly from the Heat, Rarefaction, and Efflatus of the Blood, and partly from the continual drinking, and pouring in of fresh Liquors, occasion'd, and as it were

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were necessitated by the Heat and Thirst, from which Plethora, the Impetus of the Blood being checkt, restrain'd, and its Velocity diminish'd by the great Resistance, it will be dispos'd to condense, and throw off its Serum again upon the Glands and Lymphaticks: but this Condensation is very often too precipitate, quick and sudden, and throws a greater Quantity of Serum upon the Glands and Lymphaticks, than can easily be discharg'd and got off again; in which case the Fever seems to change its Species and Appearances, and from Effluent, Arterial and Inflammatory, becomes Influent, Lymphatick, and Condensative; till this surcharge of Serum upon the Glands and Lymphaticks, by obstructing and intercepting the Circulation of the Lymph and tumefying and distending the Glands, acts powerfully as a *Stimulus* upon the nervous muscular Coats of the Arterys, and by that means throws out the Fever, and raises the Pulse and inflammatory Heat again. In which alternate Course, Nature endeavours as it were by shifting Hands, and throwing the Burden from one side to the other, to gain some Relief and Time, till a salutary Crisis can be procur'd, and the vitiated tainted Serum pass'd off by the critical Discharges: but tho' the Intention be here perfectly right, and the Structure of the Machine wonderfully contriv'd to obtain it, yet Nature itself thus oppress'd, and under such Confusion, often either over or under-does the Work; and there

therefore it is the Business of a Physician, carefully to watch these Reciprocalions in Fevers, to regard the Intention of Nature in them, and to keep up the Balance, by throwing the Weight on one side or the other, and this with a steady and wary Hand, till such time as a proper Crisis can be procur'd. How this may be done, must be very obvious from what has been already observ'd and consider'd, under the foregoing Account and Theory of Fevers; and they who are a little acquainted with the Conduct of Nature in this case, will not wonder that the same Fever should often shift its Appearances and Symptoms, so as to require alternately a different Method and Process in the Physician, as much as any two different and contrary Fevers.

## SCHOLIUM II.

BLISTERING has been found by Experience to be of such wonderful and extensive use in Fevers, and is now so generally received and practis'd by the best and ablest Physicians, that it may be worth while here to consider these Epispasticks in their Effects and manner of Operation a little more distinctly; the way of applying and dressing them, and their outward sensible Appearances in raising the Skin into large Blisters, and drawing off considerable Quantities of a hot, sharp, and salt Serum from the glandulous and fleshy Parts of the Body, are so commonly known as to need no particular Ac-

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count or Description here: but the mighty Change and turn upon the Symptoms which they induce when they are timely apply'd in Fevers, is so very great and remarkable, that I shall first recount the main Particulars, and then endeavour in short to explain the Ground and Reason of their principal Operation and sensible Effects.

1. THEY raise and strengthen a low trembling Pulse, and powerfully derive the natural Heat and Efflatus of the Blood outward; by which means they take off those convulsive Twitchings and spasmodic Contractions of the extreme Parts, which commonly attend low lymphatick Fevers: and by the same means they secure the Bowels, with the glandular and muscular Organs contain'd in the Thorax and Abdomen, from Inflammatory Tumors, Mortification, and Gangreens, which must otherwise very often be the Consequence of a too great and forcible Afflux of the hot rarefy'd Blood and Serum inward upon those Organs.

2. THESE Epispasticks speedily and wonderfully give Relief, in all those delirious Ravings, soporiferous Stupors, and loss of Reason, Judgment and Memory, which are the common and well known Symptoms of high and dangerous Fevers.

3. THEY reduce, in a short time, continual Fevers to such plain, regular, and distinct Remissions, as to make way for the use of the Bark; and consequently for a perfect Cure and safe Solution of the Fever.

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4. THEY cleanse and open the obstructed tumefy'd Glands and Lymphaticks, bring on kindly and safely the critical Sweats, let loose the Saliva and glandular Secretions of the Mouth and Throat, and bring down the thick, soluble, and critical Urines; by which means they are extremely cooling, moistening and diluting, in their Effects upon the Blood and Glands in general, how hot and fiery soever they are in themselves.

THESE are the common and well-known Effects of Cantharides, when apply'd in Plaisters to the outward Skin: but how such an extremely hot, and perfectly caustick Insect, should so mightily cool and dilute the Blood in Fevers, may be thought somewhat strange; which yet may perhaps be easily enough accounted for, after the following manner.

THE Cantharides or *Spanish* Flys, with which Blisters are rais'd, are plentifully stock'd, as is well known, with a very hot, subtile, active, and extremely pungent Salt; a considerable Quantity of which entering the Blood upon the Application of Epispasticks, is there strongly attracted by the Serum, and passes together with it thro' the several glandular Strainers and secretory Ducts.

THIS Property of the Cantharides, or their finer and most active Salts, in mixing and intimately uniting with the Serum, and passing off with it in the several Secretions, is very plain and obvious in Fact: and the Urine being a large Drain of Serum, in which a great

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Quantity passes off thro' a few small Pipes, the heating stimulating Power of the Cantharides is most sensibly felt here, so as frequently upon the application of Epispasticks, to occasion Strangurys and bloody Urine; which is yet easily prevented, or soon taken off, by drinking freely of some cooling milky Diluter, such as Milk and Water, Milk-Porridge, or especially a thin Emulsion made with the Pulp of roasted Apples in Milk and Water.

BUT tho the heating stimulating Force of the Cantharides, is most sensible upon the urinary Discharges, for the Reason already given, yet from the liberal, foul, and stinking Sweats which these Epispasticks generally bring on, 'tis plain that they cleanse and scour the cutaneous Glands likewise: and indeed, since the Serum can have no elective Power upon these Salts, 'tis plain that equally uniting with the Lymph or Serum, they must proportionally pass with it thro' all the Lymphaticks and glandular, straining, and conveying Pipes universally.

UPON this Supposition, which is sufficiently evident in fact, and from the Reason of the thing, we may conclude, that the subtile penetrating Salts, and volatile pungent Parts of which the Cantharides consist, being carry'd into the Blood upon the application of the Epispasticks, and passing with the Lymph or Serum into the glandular straining and conveying Pipes, act there by dissolving, attenuating, and rarefying the viscid Cohesions of

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the Lymph and Serum; and by stimulating the nervous Coats of the Vessels throw off their stagnating Viscidities; and by cleansing the Glands and throwing off their coagulated concremented Lymph or Serum, restore the Circulation and free Drain of Lymph from the Arteries to the Veins; and at the same time, by opening, scouring, and cleansing the expurgatory Glands, bring on the critical Sweats and Urines. And by this means 'tis evident, that these extremely subtil, active, and pungent Salts derived from the Cantharides, purge the Glands and Lymphatics universally, much after the same manner that common Catharticks do the Guts: for as the common Cathartick or Purgative Medicines, by heating, rarefying, and dissolving the viscid Cohesions of the Fluids, and stimulating the Solids, cleanse and throw off their clammy, stagnating, and obstructing Contents; so these hot, active, and stimulating Salts of the Cantharides, being endued with the same Properties, and capable of penetrating the whole animal Machine, are hereby fitted for a glandular lymphatick Purge, and to perform the same thing in the glandular, straining, and conveying Pipes universally, that the common Catharticks and Purgatives effect in the Intestines: and as this sort of Purgation restores the Circulation of the Lymph, and opens all the Sluices and Out-lets of the glandular Secretions, the Cantharides must in consequence be wonderfully cooling, diluting,

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and refrigerating in their Effects, as we find they are in fact, how hot, caustick, and pungent soever they are in themselves.

THE Quantity of Serum discharg'd by Blistering, is so very small in proportion, that the great Effects of Epispasticks cannot possibly be owing to this; since five times the Quantity brought off by Bleeding, Vomiting, Purging, or any other Evacuation, would have no such Effects: and indeed, we see Epispasticks frequently attended with very great and extraordinary Effects, where they scarce raise any Blisters at all, and where the Quantity discharg'd is very little, or next to nothing: and therefore, tho some considerable Relief may often be obtain'd by an immediate Epispastick Drain of the congested viscid Serum from some particular tumefy'd Glands, yet we must conclude the great and general good Consequences of them, as above, to be owing to their heating, attenuating, pungent Salts, mixing with the Serum of the Blood, and acting as a lymphatick Purgative, or glandular Cathartick, as before explain'd.

FROM this account of the Nature and Operation of Epispasticks, 'tis evident that their principal use is in Lymphatick Influential Fevers, or such as are commonly call'd Depressing and Nervous; but in Effluent and highly rarefactive Fevers, where the Pulse is strong, and the external Heat and Efflatus very great, Epispasticks are not to be apply'd till Bleeding in sufficient Quantities has preceded.

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ceded ; left by increasing the Velocity and effluent Impetus of the Blood, too great before, the Purples should be forced out, and a general Mortification of the Flesh ensue. But after the Velocity, diffusive Impetus, and Efflatus of the Blood, have been sufficiently moderated and restrain'd by Bleeding, the Application of Epispasticks will be of great use, to prevent the Fever from changing its Species, and turning inward upon the Bowels ; as it frequently happens where the Velocity and Efflatus of the Blood have been suddenly check'd by large Bleeding, and no due Care taken afterward to keep up and diffuse the natural Heat, till a proper Crisis can be obtain'd.

IN all delirious Ravings, and soporiferous Stupors, attended with Convulsions and Spasms, Blistering the Head is most effectual, and gives the most certain and speedy Relief. I generally apply a large Epispastick to the whole hinder part of the Head, to come up so far as the Crown, like a backward Cap or Coif ; which in this case often procures a speedy and safe turn to the Disease, and takes off the most dangerous and threatening Symptoms, after six or eight Epispasticks apply'd to other Parts have had no effect.

WHEN upon the Application of Epispasticks, the Skin and Flesh under them are but little, or not at all changed from the natural State and Colour, and presently become pale and dry, like the other Flesh ; this may be look'd upon as a mortal Symptom : nor have

I ever known any one recover after such an Appearance; for this plainly indicates the retiring of the Animal Life and Motion to the Centre, while the Blood stagnates outwardly, and leaves the extreme Parts almost in the Condition of a dead Corpse.

## S C H O L I U M. III.

HAVING mention'd Blood-letting in Fevers, and this Practice generally prevailing in all Fevers without distinction, it may not be amiss here to make some farther Observations concerning it, and to shew as briefly and clearly as I can, what may or may not be expected from it. I need not describe the Operation itself, or the manner how it is done, since that is sufficiently known to every body; but when a Blood-Vessel is cut, and the Blood by means of a Ligature oblig'd to run freely out at the Orifice, the Consequences will be chiefly these which follow.

1. SINCE the Blood flows thro' the Orifice without Resistance, or not being at all impeded by the antecedent Blood, 'tis manifest the Velocity of the Blood at the Orifice will be increas'd: that is, a greater Quantity of Blood will flow thro' the Orifice in a time given, than could have circulated thro' the Vessel during the same time in its natural state.

2. THIS Augmentation of Velocity will be greatest at the Orifice itself, where the Blood meets with no Resistance at all; and so proportionally in the Vessels which communicate

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nicate immediately with that in which the Orifice is made, while the remoter Vessels will be less drain'd and empty'd by it, in proportion to their distance from the Section : for the Blood in these, finding a free Passage to and from the Heart, thro' such Branches and Divisions of the Vessels as are very remote from the Orifice, is not much affected by it, but continues its Circulation as before.

3. THE same Quantity of Blood will be deriv'd from the Heart in the same time, during its Efflux from the Orifice, as before : for as the Velocity at the Orifice is augmented in proportion to the Resistance taken off, so 'tis evident that the Protrusion of the Blood forward, is likewise taken off by the Ligature in the same proportion ; and therefore the Velocity and *Momentum* of the Blood at the Heart, being lessen'd by one of these, as much as it is augmented by the other, it must continue the same : but this must be understood only of ordinary Blood-letting, while the elastick Spring of the Vessels, and a sufficient Quantity of the Fluid, are retain'd and kept up. For in case the Bleeding be continu'd so long till the Springs and Principles of Motion sink and fail, 'tis evident that the Quantity of Blood derived from the Heart, and sent thither in the same time, must still diminish, and at last end in a perfect Stagnation. And this must also limit the Sense of what has been asserted concerning the Augmentation of Velocity at the Orifice ; for this will happen  
only

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only while there is a sufficient Supply of Blood from the next communicating Canals: but when these are empty'd, their vascular Coats contracted, and the elastick Spring of their Fibres weaken'd, the Blood in them beginning to thicken and stagnate, the Velocity at the Orifice must diminish as the Resistance increases, or as the motive Force towards the Section is lessen'd, from the foregoing Reasons.

4. BY Blood-letting therefore, the largest, quickest, and strongest Drain, is from the Vessels immediately communicating with that in which the Section is made, which are first empty'd, while those which are more remote are drain'd more slowly, and in a less Quantity and Proportion: and this might be farther confirm'd by numerous Observations, and Experiments too plain to be disputed. Every body knows, that Bleeding in the Jugulars, or Temporal Vessels, will give the most certain and speedy Relief in any Diseases of the Head, occasion'd by a too great Afflux of the Blood thither, and an immoderate Distension of the cervical and carotid Arterys in the Brain: and in any great Inflammation or extraordinary Afflux of Blood to a particular Part, Experience has generally taught the practical Physicians to open a Vein, as near as may be to the Part affected, as finding in fact, that Vessels immediately communicating with the Section, are first drain'd and empty'd. But to be convinced of this, we need

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need only observe what happens to Animals, which bleed to death by an Efflux of Blood from different Parts of the Body: to which purpose let two Dogs be thus suffer'd to bleed, one by cutting the Jugulars, and the other by cutting the crural Vessels; and it may be observed of that which bleeds from the Jugulars, that the upper and fore-parts die first, while the lower and hinder-parts will continue their Motion under strong Convulsions for some considerable time after the upper-parts are quite dead and motionless: which plainly shews, that in this case the Blood is first empty'd, and drain'd off from the ascending Branches and Ramifications of the *Aorta*, in consequence of which the Life and Motion in the upper-parts cease, while the Circulation still remaining in the descending Branches of the great Artery, the Life and Motion in the lower Parts are continu'd some time longer. The contrary to this will happen to the Dog which dies bleeding from the Crurals; for here the descending Trunk and Branches of the *Aorta*, being first drain'd and empty'd, the Life and Motion will be first lost in these.

FROM hence we may see how much they are mistaken who conclude from the Circulation of the Blood, that 'tis indifferent where or in what part of the Body a Blood-Vessel be opened: for the Blood, say they, communicates by its Circulation, and still keeping up its *Æquilibrium*, the Effect must be the

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the same, whether a Blood-Vessel be opened in the Head or in the Foot. But this is contrary to Fact and Experience, as well as to the Nature and Reason of the Thing; and may therefore be look'd upon as a wrong Consequence from a right Principle: The Circulation of the Blood is undeniable, but this Consequence drawn from it will never be granted, as long as there are any well-experienc'd and good practical Physicians in the World.

5. FROM this unequal Derivation and Evacuation of the Blood in Blood-letting, and the broken or interrupted *Æquilibrium* of the Fluid consequent hereupon, 'tis evident that the Ligature being loos'd, and the Blood suffered to take its natural Course, it must presently be thrown into a strong intestine Commotion, Fluctuation and Effervescency, occasioned by the natural and necessary Efforts of the Fluid to regain its *Æquilibrium*, and restore its former equable and uniform Circulation, after some of the Vessels have been drain'd and empty'd in a much greater proportion than others. Now when the Blood has been thrown into this new Commotion and general Confusion, what turn it will take, and what the Consequences may be, must be very uncertain and precarious, and such as the best Physician in the World can never be accountable for: the consequence of which is, that this Practice is never to be comply'd with, without some plain, apparent, and urgent Necessity, as when

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where the same Intention cannot be safely obtain'd any other way. 'Tis possible, indeed, the Blood being put into such an intestine *Luxus* and Commotion by Bleeding, that Obstructions may be hereby removed, the Coagula and Concretions in the small Vessels dissolv'd, dislodg'd, and wash'd off, the exorbitant Effluxus and rising Tide of the vital Fluid cool'd and suppress'd; from whence great Advantages may ensue, as we see in some Cases by Experience.

BUT then on the other hand, this Practice in Fevers often brings on large and profuse symptomatical Sweats, deep and dangerous Depressions, *Deliquia*, Palpitations of the Heart; and sometimes the Fever is hereby thrown very dangerously inward, and fix'd so strongly upon the Lungs and Viscera, as afterward to admit of no Cure. For this may be taken as a certain Rule, that all Coagulations, Concretions, and viscid Adhesions of Blood upon the several Organs, if they are not soon relieved by Blood-letting, will be the more fix'd, radical, and confirm'd thereby: which ought to make us cautious in what Cases and under what Circumstances we attempt the removing Obstructions by Bleeding, since this is a Method of such a nature, that if it does not succeed, seldom leaves room for any other. I am satisfy'd, that the best and ablest Physicians will be ready to own, that there is not a greater Difficulty in the whole Practice of Medicine, than the forming a sure and right Judgment

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the same, whether a Blood-Vessel be opened in the Head or in the Foot. But this is contrary to Fact and Experience, as well as to the Nature and Reason of the Thing; and may therefore be look'd upon as a wrong Consequence from a right Principle: The Circulation of the Blood is undeniable, but this Consequence drawn from it will never be granted, as long as there are any well-experienc'd and good practical Physicians in the World.

5. FROM this unequal Derivation and Evacuation of the Blood in Blood-letting, and the broken or interrupted *Æquilibrium* of the Fluid consequent hereupon, 'tis evident that the Ligature being loos'd, and the Blood suffered to take its natural Course, it must presently be thrown into a strong intestine Commotion, Fluctuation and Effervescency, occasioned by the natural and necessary Efforts of the Fluid to regain its *Æquilibrium*, and restore its former equable and uniform Circulation, after some of the Vessels have been drain'd and empty'd in a much greater proportion than others. Now when the Blood has been thrown into this new Commotion and general Confusion, what turn it will take, and what the Consequences may be, must be very uncertain and precarious, and such as the best Physician in the World can never be accountable for: the consequence of which is, that this Practice is never to be comply'd with, without some plain, apparent, and urgent Necessity, and where

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where the same Intention cannot be safely obtain'd any other way. 'Tis possible, indeed, the Blood being put into such an intestine *Lucus* and Commotion by Bleeding, that Obstructions may be hereby removed, the Coagula and Concretions in the small Vessels dissolv'd, dislodg'd, and wash'd off, the exorbitant Efflatus and rising Tide of the vital Fluid cool'd and suppress'd; from whence great Advantages may ensue, as we see in some Cases by Experience.

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concerning Blood-letting, in the several Cases, and under the various Circumstances in which it may do good or hurt: and yet not only the general Run of Apothecarys, but abundance of young unexperienc'd Physicians, when they first set up their Practice, think they ought to make this a principal part of it; and accordingly try it almost in all Diseases, especially Fevers, and upon all Constitutions: by which Rashness and Precipitancy, a good hopeful Case is often made deplorable and altogether desperate. Indeed the taking of a small Quantity of Blood, ten or twelve Ounces, and only for once, can neither do much good nor harm in any Case: and this being so often done upon every slight Occasion, People are the more apt to believe they are the better, because they do not find themselves the worse for it; and have hereby the Satisfaction to have prevented some farther Mischief which they were never in danger of. This trifling insignificant way of Bleeding, however, is so very innocent, that I cannot heartily condemn it, since this good at least comes from it, that the Apothecary or Surgeon who performs the Operation, receives his customary Fees. But where Blood is to be drawn off in any large Quantities, or frequently to be repeated, as is commonly the Case in great Exigencys; and where any considerable good Effects are to be expected from it, it ought to be under the Care and Direction of an able and well grounded Physician: for after all, it must be allow'd, that

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that there are some Cases, particularly of Fevers, where Blood-letting is of urgent necessity, and ought not to be dispensed with; as,

1. IN strongly effluent and highly rarefactive Fevers, attended with a strong turbulent Pulse, burning Heat, delirious Ravings, and such a general Outrage and Efflatus of the Blood, as to force out the Purples, occasion bloody Secretions, and threaten an imminent Hemorrhage and Evacuation of Blood upon the Brain: in this Case Blood must be taken off without delay, and that in Quantities sufficient, as effectually to suppress the preternatural Heat, Efflatus, and Outrage of the hot, turgid, and boiling Blood. For in such an Exigence, if a sufficient Quantity be not taken off, it serves only, by exciting a greater intestine Commotion and violent Fluctuation, to render the Case much worse and more desperate than before.

2. IN any great and apparent Plethora of the Blood-Vessels, by which they are overstretch'd and distended, and the elastick restitutive Force of their muscular Coats weaken'd and destroy'd; in this Case likewise Blood must be speedily taken off, and that in a sufficient Quantity to answer the Intention: for otherwise, as before, more hurt than good may ensue. And such a Case of a real Plethora in the Blood-Vessels will discover itself plain enough by its natural and necessary Symptoms, as great outward Heats, high Colour, Lassitude, lethargick Drowsiness, asthmatick  
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Suffocations, and a dull, heavy, dragging and slow Pulse.

3. IN Peripneumonys, Pleurisy, and such-like Adhesions of the coagulated concremented Blood upon the principal Organs, if the Case is recent, and the Obstruction be not fix'd too deep upon the Glands, it may be reliev'd by Blood-letting: But in all such Cases, after the Outrage and Efflatus of the Blood are pretty well suppress'd by Bleeding, the safest way is to apply Epispasticks, in such a manner as to have their main Effects as much as possible upon the Parts chiefly affected.

4. IN Apoplexys, some sort of Epilepsys, and Vertigoes, and generally in all Cases which plainly indicate a strong and violent Tide or Afflux of the Blood to the Head, so as to threaten an Hemorrhage or Evacuation upon the Brain, a good Quantity of Blood must speedily be taken off; since in such an Exigence there is nothing else to be done, and it would be losing the Patient to wait for the Operation of any other Remedy.

5. IN extremely pungent and acute Pains, or Stitches, which sometimes come on from a sudden windy Efflatus of the Blood in the small Vessels, Bleeding even in a small quantity, is of great use; and I have sometimes known the Patient reliev'd upon opening a Vein almost as soon as the Blood begins to flow.

BUT in these and such-like Cases, where Bleeding is either necessary, or at least of some considerable use, when well directed, it requires

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quires a nice and distinguishing Hand to adjust the Quantity, and to prevent the Mischiefs which may arise from the taking off too little or too much of this vital Fluid; which is not therefore to be trusted to the slight Judgment of every one who for this purpose has provided himself with a Lance. I have often wonder'd at the great Practice in this way of some Country Barbers, who in small remote Parishes and Villages get more by Bleeding than by Shaving their Customers; and by which they procure a handsom Livelihood, join'd with another laudable Practice of Drawing Teeth. And that which has made the Practice so general, is doubtless an Imagination, that this is the shortest and easiest way to get rid of Diseases: The common People will readily advise themselves, if no body else advises them, to Bleeding; who would yet never give themselves the trouble of a little Sweating, laugh at taking a Purge, as soon be knock'd on the Head as submit to a Vomit, and think it a piece of Cruelty but little less than Murder in any one, who with ever so much Judgment or Reason should propose a Blister; tho any of these are more generally useful, and much less precarious in their Effects

BUT if this Practice be often of ill Consequence, for want of Judgment where the thing itself is necessary or useful, the Mischiefs must be still greater, where it is advis'd and resolv'd upon under wrong Circumstances: and generally

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rally in all great Depressions and Concentrations of the Blood and Humours, in all deeply fix'd and radicated Diseases, and in all such Effects of a sudden condensing Cold, as often brings on the worst of Fevers, Bleeding can never be advisable, and that Patient is well off with it who is not a great Sufferer by it.

My Design in this Scholium will be sufficiently answer'd, if it may serve in some measure to check the Over-forwardness of those who seem to look upon the Lance as a true Specifick in most Diseases, and who accordingly practise but little more than this Horse-Method, in which the Farrier certainly is generally more successful than the Physician.

I PRESUME I have said enough for the Usefulness and even Necessity of Blood-letting under a proper Care and judicious Direction, to guard against Misapprehension or Censure from any learned or well-experienc'd Physicians; and for others, whose Interest or Humour may dispose them to quarrel, I hope they will pardon me, at least when I have let them know, that notwithstanding any thing I have here said, they are still at liberty, as before, to shed as much innocent Blood as they please.

PRO

PROPOSITION XVI.

*TO explain the natural Order, and the several morbid Irregularitys of Digestion.*

THEY who have amus'd themselves upon the chymical Principles to find an acid *Mentruum* in the Stomach, capable of dissolving the Food or Aliment, and of converting it into Chyle, have never succeeded in any such Attempt: and indeed the Inquiry was undertaken and prosecuted without any Foundation, since the Chymists themselves are oblig'd to own that they could never obtain any thing of an Acid from Blood or other animal Substances. 'Tis true that Acidities are sometimes found in the Stomach and first Passages; but then they are always generated there as the morbid Effects of a bad Digestion, and are so far from helping or promoting a regular Concoction, that they always vitiate, corrupt and pervert it. And tho Acids medicinally given may sometimes help and promote the natural Digestion, where the Error was before on the contrary Extreme, and the Concoction too hot and flatulent; yet a natural Acid in the Stomach, duly and regularly secreted by its proper Glands, is doubtless a mere Chimera, and a Creature of the Imagination only.

BUT without inventing groundless Hypotheses, or creating imaginary and merely supposititious Principles, 'tis evident from *Prop. 37. Part I.* that all Bodys universally contain  
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within themselves the natural Principles of Dissolution; and that the elementary Fire and Air which enter into the Constitution of all the grosser material Substances, may, when they are once excited and put into Action, exert an expansive Force sufficient to attenuate, disunite, dissolve, and diffuse the Parts of the most fix'd, solid, and closely cohering Bodys in the World. Now to produce this Effect, that is, to excite and put into Action the elementary Fire and Air which are retain'd in the natural Texture and Constitution of all mix'd compound Bodys, and thereby to separate, dissolve and diffuse their cohering Parts, there needs nothing but a sufficient degree of *Heat*, which is the Action of the foregoing expansive Elements already in motion.

To apply this to the Business of Digestion, it may be observ'd, that the vegetable and animal Substances made use of for Food and Aliment, having been first broken, divided, and comminuted by Mastication, and softned, lubricated, and moistned with the Saliva, is protruded into the Stomach; where, meeting and mixing with the Liquors, the Mass is farther soak'd, macerated, and prepar'd for Solution. Under which Circumstances, the Stomach, by means of its muscular Coats, contracting and compressing its Contents, the mix'd Mass of Solids and Fluids is hereby retain'd and shut up in a close digestive natural Heat, the congestible Matter being at the same time continually agitated, elaborated, and intimately

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imately blended together by the muscular Force and Action of the Stomach. But here must be observ'd, that the Orifices of the Stomach during the time of Digestion, are not so closely and strongly shut up by the Contraction of their muscular Fibres, but that they open at certain Intervals to suffer the vapid Fumes to pass off, and let in fresh Air; which fresh Supplies of Air suddenly rarefying and expanding, the natural digestive Heat and Efflatus of the concocting Matter is hereby maintain'd and kept up.

THE expansive Elements naturally contain'd in all the minute divisible Parts of the concocting Matter, being thus excited and put into motion, the Consequence of this must be a Dissolution of the solid cohering Parts, and an intimate mixing and blending them with the Fluids, by *Prop.* 37, and 38. *Part I.* that is, the whole Mass will be reduc'd to a sort of thin frothy Gelly, somewhat like a very soft, tender, and slightly cohering Curd: And this is the first Act of Digestion, namely, rarefactive Dissolution.

THE concoctive Matter being thus far digested in the Stomach, it is thrust forward thro' the *Pylorus*, by the muscular Action of the Stomach, and empty'd into the *Duodenum* and small Guts, where it meets with the Bile and pancreatick Juice, and undergoes a second degree of Digestion or Concoction, which is next to be explain'd.

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Now the proper Action of the Bile and pancreatick Juice, is Precipitation: that is, the grosser Parts of the first Concoction in the Stomach, or such as could not admit of a perfect Solution and Digestion, are attracted and precipitated by the Bile, and thereby separated from the more fluid Parts: and the concocted Matter being thus attenuated, depurated, and freed from its Sediment or *Fæces*, is reduc'd to a thin, fluxile, white and oily Liquor, like Milk, and then receives the name of Chyle.

THE Chyle being thus depurated, and purg'd of its gross, excrementitious, and indigested Feculencys, is receiv'd into the Lacteals by corpuscular Attractions of those infinitely numerous and exceedingly minute Pipes or Strainers; and in the Lacteals and chyliferous Ducts it undergoes a farther degree of Attenuation and Dilution, by the Lymph, which joins it from the numberless lymphatick Glands which empty themselves into the chyliferous Ducts; and with which continu'd Current of Lymph the Chyle passes into the Blood.

THE Bile having attracted, precipitated, and separated the gross indigested Recrements of the Chyle, performs another necessary office in the animal Body, in order to perfect the Operation of the great concoctive Gland, which is attenuating the Feculencys of Concoction, which it had separated from the Chyle, and thereby keeping the Excrements from

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running into too hard and dry Concretions ; and at the same time by stimulating gently the Intestines, and promoting the muscular vermicular Motion of their Coats, it acts as a mild congenial Cathartick ; and by this means secures and carries on the natural Purgation or Secretion by Stool.

Now while these Operations proceed right and regular in the manner here describ'd, the Digestion is sound and good ; and the primary concoctive Gland performing its Office, and supplying the Blood with sufficient Quantities of well-prepar'd Chyle, the animal Functions will be *cæteris paribus*, strong and lively, and the Animal continue in a state of Health or Rectitude. But this work of Digestion is subject to various Perturbations and Irregularitys ; the principal of which it may not be amiss here to take notice of and account for.

Now the first Concoction in the Stomach, which is effected by the heating, rarefying, and dissolving Power of the expansive Elements, may be either too intense, high and strong, or too weak, low and remiss : the former is a hot and flatulent, the latter a cold and hard Digestion. And after the same manner, the consequent Depuration, and Precipitation by which the Chyle is attenuated, thinn'd and fluxiliz'd, may either be in a too high or too low degree ; the one of which is a gross and feculent, the other a sharp and acrimo-

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monious Digestion : and these being the principal Errors of Digestion, I shall proceed to consider them a little more distinctly, and to shew from what Causes they are produc'd, and how to be rectify'd.

I. WHEN the Action of the expansive Elements, or their rarefying dissolving Power in Concoction is too strong, and exceeding the bounds of Nature, the Digestion will be hot and flatulent; that is, the concocted Matter, instead of retaining its natural and due Consistence, will run into a frothy, hot, and windy Flatus: and this too highly rarefy'd Concoction, not being capable of a sufficient Precipitation, Depuration, and Attenuation afterward by the Bile, pancreatick Juice and Lymph, must continually replenish the Blood with an hot, rarefy'd, and viscid Serum; and be attended with all the Consequences of Heat, Flatulency and Viscidity, thro'out the whole Machine; such as immoderate Tension and Inflation of the Stomach and Intestines during the time of Digestion, with hot Flushing and shortness of Breath, sharp and scalding Fumes and Belches, windy Cholicks, restless watching Nights, especially after a late and plentiful Supper; periodical burning Heats, a general Indisposition to sweating, unless it be sometimes low fainty Sweats; and a liableness to be over-heated upon any little Motion or Exercise; with other such-like Effects of a too great Quantity of hot rarefy'd Air, pent up and retain'd

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ain'd in a slimy, viscous, and indigested serum.

THIS Error of Digestion is generally owing to Intemperance and want of Exercise: or very few, if any, are liable to it, but Epicures and idle Drones; who being a useless Generation to others, and ignorant of the manly serene Pleasures of Temperance and Exercise, ought in all Reason to enjoy themselves in such Company as the foregoing Symptoms; with which they have the satisfaction to put a timely End to a very short and painful merry Life. To prescribe Shop-Medicines here could signify but little, since the only means of Recovery are in every one's Hands; I mean, obstinate Temperance and proper Exercise: they who use this Remedy will need no other; and such as cannot comply with it are incurable. All the Physician can do, is to send them during Life twice a Year to the *Bath*; unless *Bristol* be thought most convenient for those who are more remote from it, as being a longer Journey, and where they will have the Advantage of drinking a little Water; and, I fear, too little in proportion to the Wine.

BUT for such as, under this Error of Digestion, visit the mineral Springs only for their Health, I have one thing to advise them, and that is, to try before they set out what moderate plain Feeding and Water-drinking will do at home; to which if they add proper Exercise, they may perhaps save Money, and

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and thank me for the Advice. But they who desire only a few short Intervals of Ease under a continued Course of Luxury and Laziness, which they are resolv'd to indulge, must use their Liberty; and for which possibly in quality of a Physician I might have some reason to thank them: tho I think no Man of a publick Spirit would thank them, excepting only the Gentleman who writ *The Fable of the Bees*.

2. FROM a defect of natural Heat, and where the rarefying dissolving Power of the expansive Elements is too weak, remiss and low, there ensues a cold and hard Digestion; in which only the thinner and more watry Parts of the Food are separated and disengag'd from the rest, while the richer Oils and volatile Salts, which cohere more strongly with the Solids, are left untouch'd for want of Heat and Efflatus sufficient to separate, dissolve, and raise them in the Decoction. Now these volatile oily Salts, which in a good Digestion are the last separated, are not in this case separated at all, but precipitated together with the *Fæces* down the Guts, and ejected by Stools; while nothing is carried into the Blood but the thin watry Parts, with such few Salts as will most easily rise and unite with the Water. In this morbid state of Digestion, the volatile oily Salts which ought to pass into the Blood, and be attracted into the Globules, being left undissolved in the Concoction, and precipitated

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with the Excrements, the Blood hereupon, or want of this Supply, runs immoderately into Serum, and loses its due Quantity and Proportion of *Crassamentum*; upon which the Pulse becomes weak and low, the natural Heat sinks, the nervous elastick Fibres and Springs of Motion grow weak, soft and flabby, the Person is dull, listless, and averse to Motion; and all the animal Powers, as it were fatigu'd and jaded, droop, languish, and decline their work: and the Blood being thus deprived of its richer Oils and volatile Salts, it will be carried to the Liver too much abounding with Serum; in consequence of which the Bile cannot be drawn off, or that which is drawn will come near the nature of common Serum or Water; and therefore not being able to perform its office in the Intestines, as a warming *Stimulus* or natural Cathartick, an obstinate Costiveness and Obstruction of the Bowels will ensue, with a continual Nausea, loss of Appetite, and inclination to vomit at every thing.

THIS Error of Digestion is often the Consequence of the former, as the last Result of it on the contrary Extreme: for the Heat and Efflatus of the Blood having been rais'd too high, and at the same time the elastick *Fibrillæ* and Springs of Motion overheated and immoderately stretch'd, Nature which cannot be always forced, being incapable of bearing any longer such a continued Tension, sinks at last into the opposite

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sive State, as here describ'd: and thus the hot Intemperance draws on the cold Penance of Nature.

WHERE this state of Digestion has been brought on by a long preceding Course of Luxury, Drinking and Excess, the case is extremely dangerous, and the Patient at best has but a lucky Chance for his Life: however, 'tis possible that it may not be altogether desperate; and what help can be obtain'd may be expected from Emeticks frequently repeated, with an obstinate Course of Riding; to which may be join'd the intermediate use of the Peruvian Bark, made somewhat opening with Rhubarb, and warming with Winter's Bark, wild Valerian, Cinnamon, *Serpentaria*, &c. to which must be added the most resolute Temperance, or Moderation, in feeding lightly upon things of an easy digestion, and abstaining from all hot, spirituous, and inflammable Liquors, how much soever a deprav'd Appetite under these Circumstances, may seem to call for their former Excesses.

A QUESTION may be started here about things easy of Digestion, and what Food is most proper for Valetudinarians: as to which, if People would only follow the Dictates of Nature, and feed moderately upon that which they find they can digest with the least Trouble or Inconvenience, they would need no other Rule; so far as this amounts to, a Man of competent Age and Experience must cer-  
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rainly be either a Fool or Phyfician ; and if he cannot direct himself in this, he is not fit to be trusted in any thing.

BUT not to leave this Matter without some account of its Theory, it may be observed here, that things made use of for Food digest very differently, according to the different state and degree of the natural digestive Heat ; for where this digestive Heat in the Stomach is too high and intense, things of the lightest and loosest Cohesion and Texture digest with the greatest difficulty : for because of their easy and too quick Solution, where the digestive Heat is greater than it ought to be, they are apt to run all into a hot, frothy, vapid *Flatus* ; which by occasioning a great Inflation and Tension of the Stomach and Bowels, hinders and interrupts the work of Digestion : on the other hand, where the natural digestive Heat is too remiss and low, things of the slightest Cohesion, and such as are soonest dissolved, digest best, and pass off with the least Trouble and Inconveniency ; whereas things of a close, hard, and compact Consistence, will not digest with such, but with great difficulty, and in the mean while lie like Stones or Lead in the Stomach.

FOR this reason, a Glass or two of Wine, good smooth stale Beer, or any such warming Liquor, is very good in what I here call a cold and hard Digestion, to promote and help forward the Decoction, where the natural Digestive necessarily requires such help : but  
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in the contrary hot and flatulent Digestion, any such Liquors at or soon after Meals are always hurtful, and ought not to be admitted at all till the Concoction is finish'd, and the digested Matter pretty well pass'd off; and even then, all that can be said for them, is, that they will be less prejudicial. But People in Health, and whose Digestion is sound and good, need not be scrupulous about any of these Matters; 'tis enough for such to take care only that they eat and drink with Moderation and Temperance, to consult Experience, and to follow the Dictates of sober Nature: but they who from a set of false Reasonings are once persuaded to eat and drink exactly by Weight and Measure, as if they could supply the various and mutable Exigencys of Nature just as they fill a Vessel, the Capacity and Discharges of which are always the same, are in great danger of falling into the Physician's hands: and this, I hope, may be a sufficient Caution against any such Cook Pedantry, and most ridiculous as well as pernicious Regularity. Such an Oeconomist might as well impose upon himself to stand or sit always in the same Place, to lie in the same Bed, to wear exactly the same weight of Clothes, and to ride or walk every day precisely the same number of Feet and Inches; nay, he must compound with Providence for continual wet Weather or continual dry, for the same immutable degree of Heat and Cold, and the same invariable con-

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stitution of the Air in which he breathes: for 'tis certain that all these may some way or other affect the Constitution, Appetite, and Digestion, so as to require sometimes larger, and sometimes more sparing Meals, and the occasional use of stronger or weaker Liquors. In short, the best Rule that I know for Health, is to observe strictly no particular Rule at all; but upon the general Principle of Moderation and Temperance, to follow the Dictates of sober Nature: and he who in this respect should resolve to govern himself otherwise, as he ought to have nothing else to do, so he must doubtless be a Man of great Consequence.

I HAVE mention'd Vomiting in this cold, low, and remiss state of Digestion; and from hence, I think, may be taken the surest Indication of the Issue or Event: for where Emeticks work well, and after a few Repetitions produce some sensibly good Effect, there may be great hope of Recovery; but where they will scarce work at all, and the muscular Coats of the Stomach and Intestines have so far lost their elastick Tone, or restitutive Force, that the Emeticks lodge upon the first Passages, and cannot be thrown off, but serve only to sink the natural Heat and animal Vigour still lower, it may be taken as a mortal Symptom, and discourage all farther Attempts.

THERE is one Symptom, which I have frequently observ'd in those who have brought them-

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themselves into this morbifick state of Digestion, by a previous Course of hard Drinking; and that is, an obstinate, continued, or fix'd Pain in the Stomach; which is most sensible while the Breast is rais'd for Inspiration, and attended with great difficulty of Breathing. Emeticks have little or no operation after this Symptom has fix'd itself for any considerable time; nor have I then known any Instance of a Person's recovering, whatever other Method might be taken with him.

BUT this Error of Concoction often comes on without any such Cause as a foregoing Course of Intemperance and excessive Drinking; and may be the Consequence of immoderate Grief, unwholesom Diet, or bad Air; as it is the common case of Girls under a *Chlorosis*. But where the Disease is the same, the Method of Cure will be much the same, whatever the Cause be; only with this difference, that when such a morbid Constitution is the Effect of a long Course of Intemperance and Excess, it is harder to be remov'd than when it proceeds from almost any other Cause.

3. IT sometimes happens, that where the first Concoction in the Stomach succeeds right enough, with respect to the measure and degree of the natural digestive Heat, yet by reason of an urinous scorbutick Salt secreted in the Glands, and thrown upon the first Passages, the consequent Precipitation is too strong: from whence it comes about, that

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not only the grosser Feculencys, but the richer Oils and volatile Salts of the Concoction are precipitated and thrown off with the Excrements; and this from the too great *Stimulus* occasion'd by these scorbutick Salts and Sabula, mix'd with a sharp acrimonious Serum.

PEOPLE of this Constitution eat plentifully, and with a keen Appetite, and yet are not nourish'd or strengthen'd by it; but continue thin, lean, and meagre, and with pale Complexions and hollow Eyes, look as if they were half starv'd. They have an almost continual grating or gnawing at the Stomach; and seem always empty but when they are eating; their Blood is generally low and poor, that is, serous and watry; they make but little Urine, and are for the most part costive; they are apt to sweat, and much reliev'd by it, because this carries off part of the Salts and Serositys of the Blood, which cannot pass by Urine, and diverts their Course from the Stomach: they are impatient of Abstinence or Fasting, and tempted to eat more than they can digest or carry off; to which a great part of the Disease is doubtless owing, for light Meals, tho the oftner repeated, best agrees with them: they cannot bear strong Liquors, even in an ordinary quantity; for tho they often do want such Recruits, yet a little will over-heat and dry them up: and finally, when this morbid State is left only to Nature, unless good brisk Exercise and great

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Temperance prevent it, it terminates at last in a Dropsy.

THIS Constitution is evidently a Scurvy, fixing itself upon the Stomach : from which primary Disease thus seated, all the Symptoms will naturally and necessarily flow. The most certain and specifick Remedys are the Mercurial and Antimonial Preparations, especially the *Æthiops*, Cinnabar of Antimony, Diaphoretick Antimony, Bezoar Mineral, and the Antihectick of *Poterius* ; any of these given either with Winter's Bark and wild Valerian, or with Rhubarb and black Hellebore, as the Constitution is either hot or cold, will eradicate the Disease : and these may be variously mix'd and compounded, with regard to the Intentions of heating or cooling, as the different turn of the Disease, or Constitution require.

4. WHERE the first Concoction in the Stomach is not afterward sufficiently depurated by the Bile, the Digestion will be gross and feculent : but this is properly a Consequence of the first Error in Concoction, that is, an hot and flatulent Digestion ; for where the digestive heat in the Stomach is too strong, the over-heated rarefy'd Matter will not be capable of a sufficient Depuration and Precipitation afterward, by the Bile and pancreatic Juice : in consequence of which, a hot and flatulent will always be a gross and feculent Digestion. And therefore what has been said under that Constitution, will be equally applicable

applicable to this; which may save me the trouble of any farther Remarks or Observations here.

PROPOSITION XVII.

*TO explain the natural Phænomenon of Sleep, with the Effects of Opium, and such-like soporiferous Drugs.*

SLEEP is an interruption or suspension of Sensation for the time being; which is either total, as in sound and deep Sleep, or partial only, when the Sleep is disturb'd, and fill'd up with Dreams: and, in consequence of the Union of Soul and Body, the Author of Nature has establish'd an inseparable Connexion between certain determinate Impressions of outward Objects upon the Organs of Sensation, and those particular Sensations themselves which are respectively excited by them: inasmuch that the Organ being duly struck and impress'd by the Object, and put into a certain vibrating or undulating Motion, the respective Sensation necessarily follows, and is inseparably connected with it. From whence 'tis plain, that the Sensation itself must be intended, remitted, or suspended, in consequence of the Intension, Remission, or Suspension of Action in the Organ, or motive elastick Nerve by which it is excited. How, or after what manner this is done, is altogether incomprehensible; but the thing itself being evidently so in fact, it must be admitted as a Law of Nature,

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Nature, as much as the Communication of Motion from one Body to another by Impulse, or the universal Attraction or Gravitation of Matter.

THE proper Action of the Sensorys therefore, or that vibrating undulating Motion into which they are excited by the Impressions of Objects, is the proper state of Waking and Exercise; as on the other hand, the Rest or Quietude and Fixation of those Organs is the state of Sleep.

THIS being premis'd, it may be observ'd farther, that any change of State, whether from Motion to Rest, or the contrary, is occasion'd by a certain painful *Stimulus*, or uneasy Impression upon the Organs of Sensation and voluntary Motion: for any such Action being either too intense, or too long continued, will become painful, from the overstretch and tensity of the motive elastick *Fibrillæ*, by which the Action is exerted and maintain'd. In like manner, Rest, or the Suspension of Action too long continued, becomes painful; because the Body cannot be long retain'd at rest in any Position, without too strongly compressing those nervous sensible *Fibrillæ*, upon which the principal Weight is suspended, and which being thus press'd and stimulated, excites the Sensation of Pain.

NOW where either Rest or Motion comes to be thus painful, the Mind, by a Law of Nature, changes the state of Motion or Rest from one to the other; and this in order to

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throw off the Pain, and get rid of the present Uneasiness, by relieving the Organs which undergo any such painful Stretch, Tensity or Stimulus.

WHILE we thus by any change of State free ourselves from any present Pain or Uneasiness, we are affected with a sensible Pleasure; and this is perhaps the only thing in which the Pleasure of Sensation consists: for instance, Heating or Warming gives us Pleasure, while it serves to throw off any present Pain or uneasiness of Cold; but the Heat being carry'd farther becomes itself painful, and then Cooling and Refrigeration gives us the same sensible Pleasure by throwing off the Pain, and freeing us from the *Stimulus* of Heat. Thus also when any Sensation or voluntary Motion, being too intense or too long continued, becomes painful, Rest, or a Suspension of any such Action, gives us Pleasure, in proportion to the strength of the *Stimulus* and Pain we are freed from: but when such Rest or Suspension of Action comes to be painful, the exchanging it for Motion, and thereby getting rid of the painful Rest, affects us with the same sensible Pleasure: and indeed, we may always observe, that the Suspension of any Action can give us no Pleasure, unless the Action itself becomes antecedently painful; and no Action can affect us with Pleasure, but as the contrary Rest is some way or other painful, and then the Action be-

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comes a Pleasure, by freeing us from the uneasiness of the contrary state of Rest.

I WOULD not be thought to assert here, that Pleasure is nothing else but the mere Privation of Pain, as if Pleasure was not as real and positive an Idea or Sensation in the Mind as Pain, for that undoubtedly it is: but I am here only considering the Occasion and Origin of those different Sensations; how they are related to each other, and by what Law of Nature they are excited in, and impress'd upon the Mind: and therefore, I say, that as Pain is the Consequence of some overstretch, tensity, or injurious violence upon the Organs, so Pleasure is excited only by the removal of any such violence, and when that is done the Pleasure ceases: thus he who eats to satisfy or appease his Hunger, finds a Pleasure in eating, only till the foregoing painful *Stimulus* is thrown off; and after this if he continues to eat on, it will be with Indifferency at least, if not with Pain and Loathing: and he who under the sense of Cold warms himself, feels the Pleasure of warming no longer than till he has thrown off the Pain and Uneasiness of the Cold; and then the Action of warming becomes indifferent or painful, as it either does not affect the good of the Machine at all, or becomes injurious and hurtful to it.

THAT this is so in fact cannot be deny'd and therefore it must be admitted as a Law of Nature: and tho the manner of it, as well as

of every thing else, is incomprehensible; yet the Reason and Necessity of it, upon the Principles of rational Forecast, Contrivance, and intelligent Mechanism, are very evident. I have observ'd before, that the animal Machine is constructed and form'd upon the Principles of Self-preservation; of which we cannot perhaps have a more convincing Proof than that which we are now considering: for nothing can be imagin'd more conducive or effectual to the Preservation of the animal Machine, than these strong prevailing Impressions of Pleasure and Pain, so rais'd and impress'd by a fix'd and standing Law, as to excite and determine us by a sort of necessity to chuse what is good and beneficial, and to avoid whatever is hurtful and destructive to the animal Nature. Upon this Principle of Wisdom, Contrivance, and Self-preservation, when the Pain, and consequently the Violence upon the Organs which occasion'd it, are taken off, the Pleasure of the means which procured any such Relief ought to cease, to let us know, that being now in a state of mere Indolence or Indifferency, with respect to Pleasure and Pain, we are at perfect liberty whether we will continue the present State, or exchange it for another: on the other hand, when any present State, whether of Motion or Rest, becomes hurtful and injurious to the animal Constitution, 'tis necessary that that which before was attended with Pleasure should now give us Pain, to make us sensible

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that we are in danger ; and that the hurtful Violence upon the Organs which occasions the Pain, ought to be remov'd by a change of State, whether from Motion to Rest, or the contrary.

BUT against what I have advanc'd in general, that the Pleasure of Sense is only the Consequence of a Relief from Pain, and that the Pleasure ceases when the Pain or the Occasion of it is remov'd ; it will perhaps be objected, that there are some things which affect the Organs with a very sensible Pleasure, where there was no antecedent Pain to be remov'd ; and that consequently the Principle does not seem universal, or unexceptionable enough to be made a standing Law of Nature : thus, for instance, any delicious Food or Fruit will have its Effects upon the gustatory Nerves, by exciting Pleasure, tho there was antecedently no Hunger, Thirst, or any other Pain of that sort to be removed. And after the same manner, Musick or Harmony will affect the auditory Nerves with an agreeable Emotion, so as to excite the Pleasures of Sound, tho the Sense of Hearing was not any ways painfully affected before ; and consequently it should seem from these and such-like Instances, that the Pain or Uneasiness is not necessary to the Pleasure of Sensation.

BUT in answer to this, it must be observ'd, that the Action of such Objects upon the Organs is of a mix'd or complicated Nature, and

and that the Sensations and Denominations of Pleasure or Pain are taken from that which is most prevailing: such delicious Foods therefore, Fruits or Liquors, which independently of any foregoing Pain of Hunger or Thirst, affect the Sense of Taste with Pleasure, are of a mix'd Composition, and contain in them an acid, or sharp pungent Salt, join'd with a volatile inflammable Oil, duly united and blended together: now either of these alone, by a too forcible *Stimulus* upon the Organs, would occasion Pain; the one by its over-cooling, condensing, and fixing Quality, and the other by its immoderate heating, attenuating, and rarefying Propertys: but while the opposite Principles are mix'd in due proportion, the *Stimulus* impress'd by the one is immediately taken off, or qualify'd and restrain'd by the other; from which conjunct Action of the contrary Principles, the gustatory Nerves are kept in a quick, but soft easy Undulation, in which consists the Pleasure of the Taste: but where either of the foregoing Principles are too predominant, or not sufficiently qualify'd and restrain'd by the other, the delicacy of the Gust or Flavour will be lost, and the Taste will become ungrateful or painful.

THE like may be understood with respect to Musick or Harmony, which consists in an artful mixing and compounding of Concords with Discords; or in a quick and sudden covering and restraining such Slurs and Jars  
which

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which otherwise would strike the Ear too forcibly and occasion Pain, and yet without which the Pleasure from the Musick could not be excited.

HAVING premised thus much concerning Pleasure and Pain, so far as they arise from the alternate Motion and Rest of the Organs of Sensation and voluntary Motion, it may now be observ'd farther, that these Organs respectively are the only ones in the whole Body that are capable of a perfect Rest, Fixation, or suspension of Action: for voluntary Motion being under the Command and Direction of the Will, must cease when the Will ceases to act; and consequently the Organs by which such Motion is perform'd, must remain in a state of Rest: and the Organs of Sensation being mov'd and excited to their proper Action by the Impressions of Objects, when these Organs are withdrawn from their Objects, or by any means compress'd and fix'd beyond the moving Force of such Impressions, these Organs must in consequence be necessarily fix'd, and remain likewise in a state of Rest: but the Muscles of involuntary, or mere natural necessary Motion, and the Glands by which the necessary Secretions are made, continue their Action incessantly in a natural and regular State, whether we are sleeping or waking: for the Action of these being natural and necessary, and not depending on any Act of the Will or Impression of Objects, they must consequently continue to

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act and perform their several and respective Offices, whether we think and exert any voluntary Motion or not.

BUT tho the Action of the secretory Organs, and of the Muscles of mere natural necessary Motion, be continual, yet it is liable to various Intensions and Remissions, the Consequences of which being very considerable, must be first explain'd before we proceed farther.

THE muscular Action of the Heart, the Lungs, the Diaphragm, the intercostal Muscles, and the muscular Coats of the Arterys in general, is very much strengthen'd and invigorated by any brisk voluntary Motion or Exercise, as is commonly known; and the reason of it is so evident, from what has been observ'd and consider'd under the Theory of muscular Motion, that it need not be farther insisted on here: but that which I am here most of all concern'd to take a particular Notice of, is, the vermicular or peristaltick Motion of the Bowels, which is propagated from the *Oesophagus* (where it begins) thro' the whole Length of the Stomach and Intestines to the *Anus*: for almost all voluntary Motion or Exercise, especially if it be strong and vigorous, must necessarily shake and stimulate the Stomach and Intestines, and thereby raise and strengthen their muscular Force and Action. But when this Action, being too intense or too long continued, becomes painful, Rest or Sleep, by taking off the foregoing *Stimulus*, must remit, weaken,

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weaken, and depress the same muscular Force and Action, in the same proportion that it had been raised and strengthened by the foregoing voluntary Motion and Exercise: and the same is farther evident from the Secretions or Evacuations of the Stomach and Intestines, which are always considerably lessen'd and abated by Rest and Sleep; insomuch that a Vomiting or Diarrhæa stops during that Interval: the Reason of which is plainly this, that the *Stimulus* upon those Organs, occasion'd by Sensation and voluntary Motion, being taken off and suspended by Sleep, the peristaltick Motion which was before too intense, is now remitted or lessen'd; and consequently the Contents of the Stomach and Intestines, before in a violent Motion from the too great Efforts of the elastick Fibres, are now suffer'd to rest quiet and undisturb'd.

THESE things presuppos'd, we may now give a short and easy Solution of the natural State or Phænomenon of Sleep; to which purpose it may be observ'd that the Organs of Sensation and voluntary Motion, having been continually employ'd for about sixteen hours, more or less, their Action from such continued stretch and tensify, becomes painful; which determines the Mind to change this State of Action for a state of Rest, in order to get rid of the present Uneasiness: to which end the Person having freed himself from the Pain of Hunger and Thirst, places himself in a soft and easy position, and under a temperature of Heat

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and Cold, and retir'd from the noise, bustle and impressi<sup>o</sup>n of Objects, composes himself to Rest: this Rest at first raises a sensible Pleasure, till the Uneasiness of the foregoing state of Action is thrown off, and then the Pleasure ceases, and the Person is reduced to a state of mere Indolence or Indifferency, with respect to Pleasure or Pain. In consequence of this indolent Rest or Quietude, the Organs of Sensation fix, and their Action is suspended: therefore those Ideas and Sensations which are excited by such organical Action, must likewise be suspended; that is, the Person will be in a state of Sleep, which is nothing else but a Suspension of Sensation, as the necessary Consequence of the Rest or Fixation of the Organs.

I HAVE observed before, that upon this Rest, or suspended Action of the Organs of Sensation and voluntary Motion, a considerable *Stimulus* upon the Stomach and Intestines being hereby taken off, the muscular Force and peristaltick Motion of those Bowels will be very much abated; of which Diminution of the peristaltick Motion, the Consequence will be plainly this; That a certain quantity of Blood, which by the Force of the foregoing *Stimulus* had been derived downward, thro' the descending Trunk of the *Aorta*, will, now the *Stimulus* is taken off, from the Resistance it meets with in its former Course, be oblig'd to pass upward thro' the ascending Trunk of the *Aorta*, to the Head and superior

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rior Parts: from this greater and more plentiful Afflux of the Blood, and rising of the vital Tide, the cervical and carotid Arterys in the Brain will be moderately fill'd, stretch'd, inflated and distended; and these Arterys thus fill'd, and distended with a greater Quantity of Blood, must press upon the Sensorys, or those Nerves which are the Organs of Sensation in the Brain, and thereby farther contribute to stop and suspend their Action, and continue the Animal in the state of Sleep.

FROM the same Compressure and Constipation of the Nerves of the eighth Pair, or the *Par vagum* at their original in the Brain, the several Branches of this Pair which are distributed to the *Oesophagus*, Stomach, Mesentery, Liver, Spleen and Kidneys, will have their muscular Force moderated and restrain'd, after they had been brought into a too strong and forcible Action, by the *Stimulus* impress'd upon them in a state of Watching and Exercise.

Now from all this it appears, that as by Sensation, Watching, and Labour or Exercise, when too intense or too long continued, the vital Tide is sunk and depress'd, the natural Heat recall'd and concentrated, the Blood thrown in too great Quantities downward, especially upon the Organs contain'd in the Abdomen; by which their Action becomes too intense, their Nerves over-stretch'd, and their Offices interrupted: so on the other hand, by Sleep the vital Tide together with the natural

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tural Heat are raised and diffused, the Pulse strengthen'd and quicken'd, the oppress'd Bowels and overstrain'd Nerves reliev'd, and the *Æquilibrium* of the circulating Blood, which had been lost by too violent or long continued Motion, is again reduc'd to its natural balance and regular state: from which 'tis evident of how great necessity and importance Sleep is, in its natural periodical Returns, to raise the sinking Tide of the Blood; to keep up and diffuse the natural Heat; to relieve the overloaded inferiour Organs, and give Nature a sort of breathing-time, to unbend and recover the over-strain'd Springs of Motion: and therefore it must be allow'd as one of the greatest Blessings with which Providence has befriended our weak, languishing, and continually decaying Constitutions, that when Sleep cannot be obtain'd in a natural way, and in the manner already explain'd, we are furnish'd with an almost certain and infallible Remedy to procure it, and to ease and mitigate those sharper and more intense Pains which would otherwise factually prevent it.

EVERY one will see, that what I here mean is Opium, or the concreted inspissated Juice of Poppys; by which wonderful Drug, rightly manag'd, Ease, Rest, and Sleep may be procur'd in the greatest Exigencys, and under the acutest Pains; and thereby a Truce obtain'd with many Diseases, which must otherwise, very often without Help or Remedy,

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soon dissolve and shatter in pieces the animal Machine.

OPIMUM abounds exceedingly with a most rich and generous volatile Oil and Salt, mix'd with a certain proportion of Resin, or a more fix'd, ponderous, and stimulating Oil and Salt: but its prevailing Principle, and that upon which its most wonderful Effects depend, is undoubtedly that natural and extremely benign *Sal volatile oleosum*, with which it so plentifully abounds.

THE first and most sensible Effect of Opium when taken into the Stomach, is a certain agreeable Sensation, or entertaining amusing Pleasure which it excites, and which seems to diffuse itself thro'out the whole animal Frame; of which Pleasure, the first and most sensible Impressions are made upon the Stomach, *Oesophagus* and Bowels, from whence it soon ascends, and affects the Brain. During this effect of Opium, the Thoughts are thrown into an agreeable Confusion, and the Mind is taken off from all other Objects and Concerns, to attend the present pleasurable Impressions upon the Nerves. In this state of ecstasick Quietude, the Pulse rises and beats quicker and stronger, the natural Heat is diffused, and the vital Tide visibly rises and strengthens, with a natural easy Afflux to the Head: in consequence of which, the cervical and carotid Arterys being fill'd, and moderately distended with Blood, and pressing upon the Sensorys and Springs of Motion in the Brain.

Brain, their Action is hereby fufpended, that is, the Perfon is reduced to a ftate of Sleep.

IF the Quantity of Opium given, be somewhat less than what is necessary to induce a sound Sleep, it affects the Person only with the foregoing pleasant confusion of Ideas, and entertains him with a thousand pretty vagrant Phantoms and agreeable Images as in a Dream, or betwixt sleeping and waking. But if Opium be given in a still lower Dose, it serves only to strengthen, animate, and invigorate, and to fit a Man for the necessary Offices and Requirements of a state of Waking and Exercise; like a moderate Quantity of Wine, an enlivening Dram, or any such sort of agreeably warming Liquor. And thus its Effects gradually rise, from a pleasing, strengthening Invigoration, to a deep and sound Sleep; which Sleep, if the Dose be too strong, may happen to be lethargick, apoplectick, and incurable.

THESE are the most general, constant, and peculiar Phænomena attending the use of Opium, in all Persons and at all Times: according to the Quantity in which it is given, it strengthens and invigorates, eases Pain, raises Pleasure, and at last terminates in Indolence, Insensibility and Sleep.

BUT before I proceed farther, it will be proper to observe here as a thing of great Consequence, that these peculiar Effects of Opium, *i. e.* the animating Invigoration, ecstasick pleasurable Confusion, and gradual Sleep which it

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brings on, are confin'd for the most part, if not wholly, to the inward use of it, or where it is receiv'd into the great depuratory and expurgatory Organ of the concoctive Gland, that is, into the Stomach and Intestines: but from the outward Applications of it, in Plaisters, Lotions, Unctions, &c. no such Effects will follow, at least not in any considerable or remarkable degree.

'Tis true, indeed, that Opium when outwardly apply'd, as aforesaid, has a mighty Efficacy in taking off an Inflammation, easing the Pain of a suppurating Abscess, and discussing of windy and flatulent Tumors; and to these purposes I have ever used it with great freedom and with equal success: and tho it cannot be doubted, but that in such an Application and Use of it, very considerable Quantities of the more subtile, volatile, and active Parts of the Opium must pass into the Blood and circulate together with it; yet I have never observed any direct soporiferous Effects from it when thus apply'd, but the Sleep which sometimes follows seems to be purely natural, and such as must have been the Consequence of a Relief from Pain, tho it had been procur'd by some other means, and without the use of any Opiate at all.

THUS far is Matter of Fact and Experience; and the accounting for these Phænomena will let us into the whole Mystery of Opium, and serve to explain all its Operations, and different Effects and Consequences of it, whether

whether good or bad, under the several particular Circumstances and Conditions of Action. But the better to clear the way to this, it will be necessary in the first place to consider a little farther the nature of Pleasure and Pain, by what Mechanism they are produc'd, and after what manner they differently affect the nervous elastick Organs. I say therefore, that Pleasure and Pain, in their Origination and mechanical Production, depend on the different nature of the *Stimulus*, or Modification of Motion impress'd upon the motive *Fibrillæ*, or nervous elastic Organs.

'TIS well known, that any violent *Stimulus*, or too strong Impression of Motion upon a particular Organ, by deriving a more than ordinary quantity of Blood to the stimulated Part, and thereby overstretching and wounding, or breaking the motive, elastick, and sensible *Fibrillæ*, will occasion Pain; which Pain is the Notification given us by a Law of Nature of any such hurtful injurious *Stimulus*, that we might from hence be excited and in a manner necessitated to take the proper Measures and Precautions for Self-preservation. On the other hand, Pleasure is excited by a quick, but soft, easy, and as it were harmonious Tremulation, or placid undulatory Motion impress'd upon the Organs. Under this Circumstance or Modification of Motion, the Blood and circulating Fluids will recede from, or rather flow in a less quantity to the Parts thus gratefully and agreeably impress'd, and

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be deriv'd in a greater proportion to other Parts, where the *Stimulus* is stronger; and in consequence of this, the nervous elastick *Fibrillæ* will contract, and recover themselves more and more at every returning placid Undulation: when by this means the Overstretch or painful Tensify of the Fibres is taken off, and they have obtain'd their utmost Restitution and proper Rest, the Pleasure will cease, and terminate in mere Indolence, in which the motive *Fibrillæ* will remain indifferent, with respect to Pleasure and Pain.

THESE things premised, the various Operations of Opium, and the several Circumstances under which it may do either good or harm, may be now easily explain'd: to which purpose it may be observed in the first place that the Opium being receiv'd into the Stomach, and there attenuated and dissolv'd by the natural digestive Heat; the volatile oily Salts with which the Opium most plentifully abounds, will be rais'd into a warm invigorating placid Steam, or grateful and easy Efflatus; from which most agreeable and placid Efflatus, the nervous Coats of the Stomach, *Oesophagus*, and Intestines, will be affected by immediate Contact, with a quick soft, easy and undulating Titillation: and upon this account it may be said, that Opium affords the same pleasurable Gust, or agreeable Sensation to the Stomach, and, as we shall shew, to the Nerves in general, that a Pine-

Apple

Apple or some such delicious Fruit, does to the gustatory Nerves upon the Tongue and Palate: for indeed, the Pleasure of Opium is so great, so extensive and generally diffused, and at the same time attended with such variety of pleasing Images, that it cannot be known or understood but by those who have try'd it, under some antecedent painful *Stimulus*, or pressing Uneasiness; and thereby acquainted themselves with the wonderful Relief and sensible Pleasure it gives by Experience.

It must be observ'd in the next place, that the *Oesophagus*, Stomach, Intestines, and all the Viscera contain'd in the Thorax and Abdomen, are supply'd with Nerves, not from the spinal Marrow, but from the Branches and Ramifications of the Nerves of the eighth Pair, or *Par vagum*, which takes its rise in the Brain itself, by numerous small Filaments springing from the sides of the *Medulla oblongata*: and from hence it must come about, that when the Branches of the *Par vagum*, which supply the *Oesophagus*, Stomach, and Intestines, are affected by immediate Contact with the foregoing easy placid Motion and Sensation, the other Branches and Divisions of the same Nerves in the Heart, Liver, Spleen, Mesentery, Kidneys, &c. must be brought into the same pleasurable Motion and Sensation, by Consent and Communication: and this must be continu'd thro' all the Branches and Ramifications of the same pair

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of Nerves, up to their original in the Brain. And indeed, all the Nerves, by their natural and necessary Communication with each other, will be affected in some measure after the same manner; as the several concordant Strings of a musical Instrument will receive the same Modification of Motion, when one of them is struck, tho the greatest Emotion and most sensible Effects will be observ'd upon that String which was directly and immediately impress'd. And thus any painful *Stimulus*, wherever it happens, may be taken off by the use of Opium, in consequence of this sort of harmonical propagation of Motion from one Nerve to another; tho the Pain does not reside directly in any of the Branches and Ramifications of the *Par vagum*, which are first and most immediately affected by the Opium as above explain'd.

Now this easy undulating placid Motion of the Nerves, being continued till all the painful *Stimulus* upon the Parts is taken off, and till the Organs of Sensation have obtain'd their greatest state of Contraction, Restitution and Rest; the Pleasure then ceases, and terminates in Indolence: and the Action of the Sensorys being thus suspended, there must be consequently a Suspension of Sensation: that is, the Person will be reduc'd to a state of Sleep,

BUT farther, from the easy, agreeable and most placid Efflatus in the Stomach, occasion'd by the rarefy'd or sublimated volatile

oily Salts of the Opium, the Stomach will be moderately and pleasurably inflated and distended; and by that means bear upon the descending Trunk of the *Aorta*: at the same time all the painful *Stimulus* or Irritation upon the Organs, which are supply'd with Blood from the descending *Aorta*, being taken off, the Blood which was before deriv'd in too great Quantities to those Organs, so as to over-stretch them, will now from both these Causes conjunctly, be sent in a greater Quantity and Proportion to the Head and superior Parts: and this must strengthen and confirm the disposition and state of Sleep, in proportion as the Sensorys in the Brain are compress'd and fix'd by the turgid distended Blood-Vessels.

FROM this general account of the nature of Opium, and the manner of its Operation, it will be easy to understand the true Use of it, and in what particular Cases, or under what Circumstances it may do either good or hurt: for that Man certainly is not fit to give Opium, or any thing else of efficacy, who is not duly appriz'd of its ill as well as of its good Consequences; and there cannot be a surer mark of a Quack, or an Ignoramus in his Profession, than to hear a Man cry up any thing as unexceptionably good, or declaim against it as universally hurtful. I know the common People are exceeding fond of universal Remedys, and Catholicons in Physick; tho there is nothing in which they

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are more abused and misled, or from which they suffer greater Mischiefs and Inconveniencys with regard to their Health: since this gives Quacks and knavish Pretenders an opportunity of picking their Pockets, by imposing on them things of no value at a great Price. But this, however, may be taken as a general Rule in Physick, That there is nothing which in some Cases will do a great deal of good, but what will certainly do as much harm in others: and this is especially verify'd in the Case of Opium, which is either a great Friend or a great Enemy to Nature, just as it is apply'd and made use of. For the sake therefore of young Physicians, I shall here make some practical Observations, by which the foregoing Theory may be the better understood and apply'd.

I. 'TIS of great consequence to observe, that Opium, with regard to its proper, direct, and immediate Action, is purely and simply a Nervine, and affects the Fluids only secondarily and symptomatically, by means of the different Determination or Modification of Motion with which it impresses the Solids, or the motive, elastick, and sensible *Fibrillæ*: for since it immediately affects the Nerves, or motive elastick Fibres, with a soft, smooth, easy, and placid Undulation, 'tis manifest that its great and principal Efficacy must consist in restraining and moderating any violent and preternatural *Stimulus*, or too strong and forcible Impression of Motion upon the

Nerves.

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Nerves. By this means, any immoderate Afflux of the Blood or Humours to a particular Part, being check'd, suspended, and diverted some other way, Nature has time to breathe, and recover the *Æquilibrium* which had been lost by any such too strong and forcible Irritation and *Stimulus* : and hence it is, that Opium is so effectual in stopping a Diarrhæa, and in checking and restraining any immoderate Flux of the Blood or Humours, which had been occasion'd by some violent *Stimulus* or Irritation upon the muscular and glandular Organs : for this Irritation and Violence being taken off, by the grateful Impressions of the Opium upon the nervous, motive, and sensible *Fibrillæ* ; 'tis evident that the immoderate Afflux of the Fluids to the stimulated Parts, must hereby be restrain'd, moderated, and diverted another way.

Now this being the peculiar and most direct effect of Opium, to check and restrain any violent *Stimulus*, or too forcible impression of Motion upon the Nerves ; 'tis manifest that the injudicious unseasonable use of it must do a great deal of mischief: for by this means it must gradually weaken and destroy that Elasticity and motive Force of the *Fibrillæ* which is natural and necessary, suspend and lock up the natural Evacuations, diminish the Velocity of the Blood, and at last induce a general stagnation of the animal Fluids, for want of elastick Force sufficient to keep up and carry on their Motion and Circulation.

WHERE

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are more abused and misl'd, or from which they suffer greater Mischiefs and Inconveniencys with regard to their Health: since this gives Quacks and knavish Pretenders an opportunity of picking their Pockets, by imposing on them things of no value at a great Price. But this, however, may be taken as a general Rule in Physick, That there is nothing which in some Cases will do a great deal of good, but what will certainly do as much harm in others: and this is especially verif'd in the Case of Opium, which is either a great Friend or a great Enemy to Nature, just as it is apply'd and made use of. For the sake therefore of young Physicians, I shall here make some practical Observations, by which the foregoing Theory may be the better understood and apply'd.

I. 'TIS of great consequence to observe, that Opium, with regard to its proper, direct, and immediate Action, is purely and simply a Nervine, and affects the Fluids only secondarily and symptomatically, by means of the different Determination or Modification of Motion with which it impresses the Solids, or the motive, elastick, and sensible *Fibrillæ*: for since it immediately affects the Nerves, or motive elastick Fibres, with a soft, smooth, easy, and placid Undulation, 'tis manifest that its great and principal Efficacy must consist in restraining and moderating any violent and preternatural *Stimulus*, or too strong and forcible Impression of Motion upon the Nerves.

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Nerves. By this means, any immoderate Afflux of the Blood or Humours to a particular Part, being check'd, suspended, and diverted some other way, Nature has time to breathe, and recover the *Æquilibrium* which had been lost by any such too strong and forcible Irritation and *Stimulus*: and hence it is, that Opium is so effectual in stopping a Diarrhæa, and in checking and restraining any immoderate Flux of the Blood or Humours, which had been occasion'd by some violent *Stimulus* or Irritation upon the muscular and glandular Organs: for this Irritation and Violence being taken off, by the grateful Impressions of the Opium upon the nervous, motive, and sensible *Fibrillæ*; 'tis evident that the immoderate Afflux of the Fluids to the stimulated Parts, must hereby be restrain'd, moderated, and diverted another way.

Now this being the peculiar and most direct effect of Opium, to check and restrain any violent *Stimulus*, or too forcible impression of Motion upon the Nerves; 'tis manifest that the injudicious unseasonable use of it must do a great deal of mischief: for by this means it must gradually weaken and destroy that Elasticity and motive Force of the *Fibrillæ* which is natural and necessary, suspend and lock up the natural Evacuations, diminish the Velocity of the Blood, and at last induce a general stagnation of the animal Fluids, for want of elastick Force sufficient to keep up and carry on their Motion and Circulation.

WHERE

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WHERE any such injudicious and immoderate use of Opium has induc'd a too great Quietude and Fixation of the Nerves, and a consequent Viscidity and cohesive Lensor of the Fluids, sticking upon the Glands and clogging the principal Springs of Motion; the best Restoratives, and most effectual means of recovering such an impair'd Constitution, will be a keen, dry, and strongly elastick Air, cold bathing, Water-drinking, often riding, and daily Exercise; frequently repeated Vomits, fetid aromattick Bitters, and the milder and safer Preparations of Mercury and Antimony, made opening with Rhubarb, and especially join'd with black Hellebore.

2. As the far greatest quantity of Blood is sent downward thro' the descending Trunk of the *Aorta*, it comes about from hence, that those Bowels and Organs which are continually supply'd with Blood by this way, are most liable to be clogg'd, and over-loaded with a too great Weight and Impetus of the Blood and Lymph; especially after long Watching, hard Labour, great Cold, immoderate Grief, and such-like Causes. To remove and remedy which, while the Injury is recent, and before the Disorder is too strongly fix'd, Opium has a most certain and prodigious Efficacy; and this it does by raising the vital Tide, quickning and strengthening the Pulse, and diffusing the natural Heat, after the manner already explain'd.

BUT

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BUT then if too much indulg'd, or continu'd beyond the reason and necessity of the case, it must needs be follow'd with Evils on the contrary extreme, equally mischievous and destructive with those which it was intended to remove : for besides the general ill Consequences already mention'd, the immoderate or unseasonable use of it for the reason now assign'd, disposes to Lethargys, Apoplexys, Vertigoes, Blindness, and the most dangerous Spasms or Convulsions, especially of the Head and Stomach. In short, there are no Diseases which are commonly brought on by the too large and liberal drinking of hot fermented Liquors, and inflammable Spirits, but what may be induc'd by the immoderate use of Opium : and indeed the Danger is the greater to those who have taken to it, from the innocent Pleasure it seems to give, and the silent insensible manner in which it draws on the long train of unsuspected Evils.

3. IN all condensing Colds, which throw the Lymph and Serum immoderately upon the Glands ; in violent Coughs, beginning Consumptions, and all Injurys of the Bronchia ; while they are recent, and before the Glands are too much loaded, and the obstructing Matter obstinately fix'd, Opium, under a careful Management, is extremely beneficial : for by restraining and reducing the violent Motion of the stimulated Nerves, it prevents the farther Derivation of the  
Blood

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Blood and Serum to the Parts affected; and by thus giving the over-stretch'd *Fibrillæ* liberty to contract and restore themselves, they will be enabled to renew their Action, and to throw off the stagnating Matter that is already lodg'd upon the Glands. And this is the first and best end that can be put to such Evils, because it nips the Disease in the bud, and cuts off its supplies of fresh Nourishment, before it is too far grown and advanced.

BUT I would not have it concluded here, that Opium in this case will effect the Cure without any farther assistance: for tho it may possibly, under a skilful Direction, even of itself cure a beginning or arising *Phthisis*, yet it is hardly ever to be trusted alone; since in any case which requires much time, after the Opium has taken off the preternatural *Stimulus* upon the nervous motive *Fibrillæ*, it will by its continu'd use, without abundance of care, destroy their natural Action too, and bring them to such a state of Fixation and Rest, as to render them incapable of their proper and necessary work.

BUT before the Matter can come to this pass, the observing Physician will have a plain and natural Indication of what he is to do farther: for when the viscid cohering Serum begins to be thrown off from the tumefy'd obstructed Glands, in the manner and by the means just now mention'd, Nature, for the most part, endeavours presently to discharge the vitiated Lymph into the Stomach, in or-  
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der to be thrown out of the Body that way; and this soon discovers itself by Nauseas, Loathings, and an inclination to Vomiting: Vomits therefore in this case are plainly indicated, and in fact scarce ever fail to answer the Intention. For Emeticks, given under a proper Direction, and repeated as occasion serves, that is, till the Symptoms vanish, soon perfect the Cure: and nothing can be more natural, reasonable, or safe, than this Operation; by which the putrefy'd vitiated Principles of such Diseases are drawn off from the Blood, and cast out of the Body, as fast as they are discharg'd from the tumefy'd obstructed Glands.

BUT where any Disease of this kind is too far advanced, that is, where the affected Glands are so far loaded and distended, or tumefy'd and inflam'd to such a degree, that the Matter cannot admit of Discussion, but must necessarily come to a Suppuration and Abscess; Opiates in this case can do no good, but must certainly do a great deal of hurt, with respect, I mean, to the Disease itself; unless it be merely for the sake of present Ease, when that is the only thing in the Physician's power.

4. THERE is one particular case in which Opiates are of excellent use, and which therefore I here beg leave to mention, for the sake of young Physicians; since they who are abler and more experienc'd in their Profession, can have no need of it: what I mean is the case  
of

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of Child-bearing Women, who are often tormented for many Days together, and sometimes for several Weeks, by turns, with slow, lingring, grinding, but ineffectual Pains; by which Nature is frequently weaken'd, and depress'd to such a degree, before the great Exigence, that she sinks at last under the weight and burden of the Work: besides, the Child having been long stimulated and pain'd, grows still weaker, and is many times by its Efforts under the *Stimulus* and Pain, entangled and thrown into a wrong Position, so as to render the future Birth impracticable without great Violence. In this case Opium is the only safe effectual Remedy; and a noble Pacifier both of the Mother and Infant: nor need any one fear lest by this means the natural time of the Birth should be protracted, and injury done that way; for when the Pains come in earnest, and to good purpose, they will easily explain their Nature and Design, and the speedy Event will put the whole matter out of doubt.

BUT most pernicious is the Practice of those, who at the supposed time of Delivery, give what they call *Forcers* to hasten on the Work; by which Nature being forc'd upon an unreasonable stretch, the Birth precipitated, and the Ligaments violently torn off; an Hemorrhage often ensues, with a fatal Crisis, which leaves no farther work either for Physician or Midwife: but even at this Season, if necessity requires, a moderate Dose

of

of an Opiate given, that Nature may have a little time to breathe, and to wind up the Springs of Motion, in order to renew the Work with fresh Efforts, is certainly the safest and most rational way.

WHAT has been said of the lingering ineffectual Pains before the Birth, may be equally understood of the After-pains, which when sharp, intense and violent, must be effectually reliev'd by Opiates in sufficient Doses; this not being done, a Fever often ensues, more perilous than the Labour, and in which the greatest danger is yet to come. And indeed, when Opiates are given so far only as to take off the Pain, and recover the elastick Tone of the over-strain'd Vessels, nothing can be more effectual to bring off the After-birth, and promote the necessary Cleansings, whatever some may imagine to the contrary: but when the Pain is remov'd, and the Strength a little recover'd, the Opium has done its work by answering its proper end; and then any Man's Reason will tell him that it ought to be laid aside.

5. NOTHING is more expected or desir'd by young Physicians, than to be rightly inform'd of the just and certain Doses of Medicines; and yet there is perhaps no particular, in which the most able and experienc'd are less capable of giving them Satisfaction: for my own part, I have always thought the Pains of those Gentlemen to be very much lost, who have gone about to adjust nicely the  
Doses

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Doses of Medicines, which is a work, I must acknowledge, that my Philosophy is not at all equal to, and in which, I think, a Physician can have no sure Guide but Experience. They who have writ of Opium, have been especially careful to limit the Dose of it; which, in general, they will not allow to exceed three or four Grains at most: but from this Limitation, if taken as a general Rule, a young Practitioner will scarce be ever the wiser; for as such a Dose in some Cases may be enough to kill, so in others it will be of little or no consequence. In general, it may be observ'd, that in all Diseases where there is any great Afflux and Determination of Blood to the Head, the use of Opiates ought to be resolv'd upon with great Caution, since in such cases small Doses are sometimes attended with very bad Effects; but where there is any strong and violent *Stimulus* and Pain in the inferior Parts, as the Stomach, Intestines, or Abdomen, deriving the Blood very powerfully downwards, and which threaten a Gangreen or Mortification of the Bowels, Opiates must be given freely and in large quantitys, till they have answer'd their end: for in such Exigencys, a Physician must not stand by and lose his Patient in point of Ceremony, or from any trifling regard to canonical stated Doses; and if three or four Grains will take no effect, the same Dose must sometimes be repeated once more, or perhaps twice in the space of six or eight Hours; which I have some-

sometimes found to be no more than necessary. I speak not this, however, to encourage young Physicians to venture on any such high Doses slightly, but only to shew the Necessity of diligent Observation and Experience, and the Insignificancy of any general Rules and Precepts in Physick without it.

PROPOSITION XVIII.

*TO explain the Origination and Mechanism of the PASSIONS, with regard to their different Modifications, and Impressions of Pleasure and Pain.*

WE find, by reflecting inwardly upon ourselves, that there are various Modifications and Impressions of Pleasure and Pain, inseparably annex'd by a certain establish'd Law of Nature, to the several Judgments we form concerning Good and Evil: these Judgments, with their peculiar Modifications of Pleasure or Pain annex'd, according to the various Appearances and Relations of the Object consider'd either as good or evil, present or absent, certain or uncertain, probable or improbable, possible or impossible; and affecting the Machine after a certain particular manner, peculiar to the distinct Modification, are what we call *the Passions*.

IN every Passion therefore, there are three things to be consider'd, as necessary and essential to it:

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I. THE

I. THE bare intellectual Judgment concerning the Object, under its peculiar and respective Qualifications and Appearances, as aforesaid.

II. THE particular and determinate Modification of Motion, hereby impress'd upon the Organs, or elastick motive *Fibrillæ*, in consequence of such a Consideration and Appearance of the Object. And,

III. THE peculiar Modification of Pleasure or Pain, which is at the same time excited in and impress'd upon the Mind.

I DESIGN not here an exact, methodical, or systematical Discourse of the Passions; but to consider them only so far as they come within the Province of a Physician, or with respect to the different Effects and Consequences of their various and different Modifications and Impressions of Pleasure and Pain: and therefore it may be observ'd, that all the Passions arise, and are generated and form'd, from that natural Principle of Self-preservation, or necessary invincible desire of Pleasure or Happiness, which is essential to every intelligent Being, and which is the great and only Spring of intelligent Action. I do not say that the Pleasures and Pains attending the Passions are the only Causes, or properly speaking any Causes at all of Action; for in strict speaking, the Agent himself is the only Cause of the Action: and to confound the  
Motive

Motive with the Agent or Cause of Action, must be extremely absurd and unphilosophical.

BUT tho the Motive is not, perhaps, absolutely necessary to the Action itself as such, because for any thing that appears to the contrary, an Agent may act absolutely without a Motive ; yet some wise and reasonable Motive or end of Action, is certainly necessary to all wise and reasonable Action. To act without a Motive, would be the same thing in effect as not to act at all : that is, such an Action could answer no farther or better end than not acting ; and consequently the Action, as well as the Agent, would be so far perfectly insignificant, redundant and useless. He who should have no Object at all of his Love or Aversion, Hope or Fear, Joy or Grief, must be simply and purely indifferent to all Action ; and consequently must be either in a state of perfect Rest and Inaction, or at least in a state equivalent to it, and in which the Actions of such a Being could be of no more signification or consequence, than the uncertain fluctuation of an Atom, or the whivering of a Feather in the Air : and therefore we cannot think or speak of the Actions of the supreme Being, or God himself, without ascribing to him these Motives and Passions. And tho, as the Divines tell us, and as we must undoubtedly believe, these Passions, and Motives of Action are ascrib'd only metaphorically, analogically, or figuratively to God, and cannot

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strictly and properly belong to a Being absolutely perfect ; yet this plainly shews what the Springs of Motion are in ourselves, and that we can find no other principle or ground of Action, by reflecting upon the Operations of our own Minds.

NOW this great Spring of Action, or Principle of intelligent Motion, is in one word the *Desire* of Happiness ; from which all the Passions arise, and of which they are but the various and different Determinations or Modifications, according to the various and different Appearances, Positions, and respects of the Object.

THUS, that I may give some Instances, the Desire of any thing under the apprehension and appearance of its goodness, suitableness, or necessity to our Happiness, constitutes the Passion of Love : but the Desire of eschewing or avoiding any thing, as apprehended to be mischievous, hurtful, or destructive, constitutes the Passion of Hatred, or Aversion. The desire of any Good, which appears at the same time probable and in our power, constitutes Hope ; but if the Good we desire appears improbable, difficult, or impossible, it accordingly constitutes Fear and Despair. The desire of regaining any lost Good is Grief ; and the unexpected Gratification of Desire is Joy : the desire of Happiness to another under Pain or Suffering, is Compassion ; and the desire of another's Punishment, Misery or Suffering, beyond the reasonable  
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end and necessity of the Suffering itself, is Revenge or Malice; which is a Passion absolutely evil, and where it governs and prevails, it constitutes a Being perfectly and completely wicked, hurtful and destructive, such as can be only the just Object of Aversion and Hatred.

IT would be needless to give any more particular Instances in this case, since, as I have said, I intend not here an exact methodical System of the Passions, but only to consider them so far as they come within my profess'd Design: but what has been observ'd, may, I presume, be sufficient to shew, that the several Passions are nothing else but the various, determinate, and objective Modifications of that natural, necessary, and invincible *Desire* of Happiness, which is to us, at least, under our present Circumstances, the great and only Spring, Weight, or Movement of intelligent Action.

IT may be proper in the next place to observe farther, that this *Desire* of Happiness is a certain painful Sensation, or uneasiness of the Mind, under a sort of *Stimulus*, craving Appetite, or apprehension of something still wanting: for whoever will observe the matter nicely, must find that there is always just so much of Pain or Uneasiness under any present Circumstance, as there is of Desire to get rid of it, or exchange it for some other; and such a painful *Stimulus*, or uneasiness of Desire as this, is, as far as we can apprehend,

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plainly necessary to all imperfect Beings, that are capable of a continual Growth and Improvement of Happiness and Perfection: for we cannot conceive that any thing less could be a sufficient Motive, Provocative, and Incitement to such continued Action, as is necessary to the continu'd uninterrupted Pursuit of those farther and farther degrees of Happiness that are still attainable. Perfect Pleasure, without any composition or mixture of Pain, is perfect Happiness; and must therefore be peculiar to that Being who is absolutely perfect, and consequently incapable of any farther additional Acquisitions. I am oblig'd here frequently to intersperse such Cautions and Restrictions, because I would not have what I say in describing human Nature to be apply'd to the supreme Being, or God himself, of whose modify'd Actions and state of Happiness we cannot judge.

To proceed therefore, it must be observed farther, that in consequence of the several Judgments we form concerning Good and Evil, under the various respective Appearances and Considerations of the Object, the motive Organs, or nervous elastick *Fibrillæ*, are impress'd or stimulated after a certain particular and determinate manner; such as is peculiar to the particular respective Judgment or Consideration of the Object: and in this case the Sensation excited in the Mind, and the particular Modification of Motion impress'd upon the Organs, are certainly reciprocal,

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procal, and follow mutually from each other, whether the Impression be suppos'd to be first made upon the Body or upon the Mind : that is, any strong, violent, and preternatural Impression of Motion upon the Organs, will excite a painful Sensation in the Mind ; any such painful Sensation, supposed to be first excited in the Mind from the bare intellectual Consideration of the Object, will consequently impress a strong, violent, and preternatural Motion upon the respective Organs. Thus also any soft, easy, and placid Undulation, impress'd originally by the actual impulse of Objects upon the Organs, will excite a pleasurable Sensation in the Mind ; and after the same manner, a like pleasurable Sensation being originally excited in the Mind, from the mere intellectual Contemplation of Objects, and without any material Action of the Object at all, will be follow'd with a like soft, easy, placid Undulation of the Organs : and by this inseparable Connection establish'd by a Law of Nature, the Body and Mind are mutually impress'd, and act reciprocally upon each other. But if it should be here ask'd how this mutual Communication is brought about, after what manner it is done, or whence it proceeds ? I would fain know how Motion is communicated from one Body to another by Impulse ? how Matter attracts Matter at a distance, and without any Impulse or intermediate Contact at all ? or how the same quantity of Motion, abating external Resist-

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ance, is continu'd and propagated *in infinitum*, when the visible Cause ceases after one single instantaneous Act? And when any Man can explain any one of the Laws of Nature, I will undertake to explain all the rest: but in the mean while it will be sufficient to lay down and evince any such Law of Nature as most certainly true, and evident in fact; and they who cannot think fit to resolve them all into the original Will and continu'd Agency of the first Cause, may invent as many other intermediate and imaginary Causes as they please; but after they have gone a great way about, they must perhaps return at last to the same point, or never come to any issue at all: and for my own part, I cannot imagine what Men should mean by a Law of Nature, but the continued regular Operation of the first Cause, or Author of Nature, acting constantly and uniformly, after this or that particular manner.

I SHALL proceed therefore to lay down in this case what I find to be plain in fact, and to draw such Consequences from it as I apprehend most necessary to the present Purpose; leaving others to search farther into the deep and hidden Springs of Nature, and to explain its Laws in the best manner they can, without the help of a first Cause.

'TIS therefore plain in fact, that the painful Passions, as well as bodily Pain, impress the motive Organs, or nervous elastick *Fibrillæ*, with a strong and violent Motion, which

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which brings them alternately into strong and forcible Contractions and Dilatations; or strengthens and increases their muscular Force and Action: now while this Pain or uneasiness of Desire annex'd to the Passions, and with which the Nerves are thus impress'd, is moderate, and restrain'd within the bounds of Nature, either by a seasonable and proper gratification of the Passion, or by the command and direction of Reason; such moderately stimulating Desires have a good effect, as they strengthen muscular Motion, keep up the Circulation of the Blood, promote the natural and due Secretions, and excite a Man to such Actions and Exercises, in which the animal Health, Life and Vigour consist. But where the Pain or Uneasiness annex'd to the prevailing Passion is too strong and violent, and the Passion not seasonably gratify'd, or not moderated and over-rul'd by Reason; such a violent and continu'd *Stimulus* will gradually derive a too great quantity and proportion of Blood to the stimulated Organs; by which their Vessels will be over-stretch'd, tumefy'd, and distended, their muscular Force weaken'd and gradually impair'd, the *Æquilibrium* of the circulating Blood and secreted Liquors interrupted and broken, and the whole Machine put out of order; and in consequence of this, the mental Pain and *Stimulus* of Desire, will be join'd and inforc'd with an obstinately fix'd and complicated Train of bodily Illnesses and Pains, from the necessary establish'd Laws of Union

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Union and Communication between the Soul and Body.

WHILE we are throwing off, or freeing ourselves from the pain and uneasiness of Desire annex'd to any Passion, we feel a very great and sensible Pleasure, or agreeable Emotion; and the Organs hereupon falling into easy, uniform, placid Undulations, the too great Current and Fluctuation of the Blood towards them is diverted, and the *Æquilibrium* and natural Motion restor'd; and from hence any ill Effects of an antecedent too forcible *Stimulus*, will in a certain degree and measure be naturally thrown off: but as soon as all the pain or uneasiness of Desire is perfectly remov'd, either by gratifying the Passion or over-ruling it, the Pleasure ceases, and terminates in mere Indolence, which disposes the Person to Rest or Inaction; till the return of some fresh Desires, stimulating to farther Action, renews the same Succession and interchangeable Series of Pains and Pleasures. And this is the Circle of animal Life: as the *Stimulus* of Desire throws off the Indolence of Rest, and excites to Action, so the Gratification moderates the Pain of Desire, creates a Pleasure at first, and then terminates in the former Indolence and Inaction; till fresh Desires returning, stimulate to farther Action, and continue the same Round.

THUS stands the case in general; but I take this to be a matter of such consequence, that perhaps it may be proper here to be a little

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little more distinct and particular ; to which purpose I shall in the first place lay down the following Phænomena as matter of Fact and Observation.

1. **THEN**, in the Passion of Love, where it is found alone, and not mix'd or join'd with any other very strong or sensibly prevailing Passion, the Pulse is equal and uniform, but somewhat more intense and strong than usual ; the Act of Respiration is modify'd just after the same manner with the Pulse ; the Person feels a certain mild, sweet, and pleasing Heat or Warmth in the Breast ; and the Digestion in the Stomach is somewhat quicker than ordinary, but easy, free, and natural.

2. **IN** Hatred or Aversion, where the Passion is strong and sensible, the Pulse is weak, low, and unequal ; sometimes quick and tremulating, and then again slow and interrupted, and the Act of Respiration is modify'd much after the same manner ; cold streamings are felt in the Breast, mix'd with a certain sharp pungent Heat ; the Person is affected with Nauseas and a Disposition to Vomiting, and the Digestion of the Stomach is weak, slow, and altogether perverted.

**THIS** Passion, where it is become habitual and prevailing, induces great Weakness, a Constriction of the Bowels, a salt watry Blood, Tumors and Indurations of the Spleen and Mesentery ; and in short, all sorts of influent, scorbutick, and glandular Diseases, as the Constitution is more particularly disposed.

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3. IN any sensible emotion of Joy, the Pulse is uniform and quick, but not so intense and strong as in the Passion of Love; the Respiration is free and easy, but not strong; and the Breast, in breathing, is retain'd rather in a somewhat raised Position than depress'd: the Person feels a grateful Heat, which beginning in the Breast, that is, in the Heart and Lungs, diffuses itself outwardly together with the Blood thro' the extreme Parts: in this case, the digestive Action of the Stomach is somewhat impair'd, and the Appetite lost. When this Passion rises very high, the Pleasure is too intense; upon which the Nerves fixing, and losing their Spring, the Pulse suddenly sinks, and the Person dies as in a Trance or Ecstasy. But Instances of this kind are very rare.

4. UNDER the Passion of Grief, the Pulse is weak and low; the *Oesophagus* and upper Orifice of the Stomach are strongly contracted, which render the Act of swallowing difficult; a certain cold, condensing Pain is felt about the *Oesophagus* and at the Heart, which diffuses itself in chilly Streams over the whole Body. When the Grief is moderate, the Appetite and Digestion are not much hurt by it, but sometimes the Appetite is better than the Digestion; and what is eaten with a seeming Hunger, cannot be well carry'd off, but lies hard and heavy upon the Stomach. But where this Passion is strong and violent, as being mix'd with Fear, and arising from the

the apprehended loss of some great irreparable Good, and thereby terminating in Despair, 'tis almost impossible to express the dismal effects of it : for by its violent *Stimulus* and forcible Contraction, it constringes and compresses the *Oesophagus*, Stomach, Intestines, and Mesentery ; destroys the Appetite, constipates and shuts up the Lacteals, and cuts off the Communication between the Stomach and the Blood ; and in this state, under extreme Anguish and Horror, it soon wastes and melts away the Flesh, reduces the Body to a perfect Skeleton, and the Person resigns his Breath, and falls an emaciated Victim to the vengeance of the Passion, leaving nothing for the Worms but Skin and Bones.

5. HOPE is much of the same nature with Joy, and is only a particular Modification of it, and therefore need not be particularly insisted on here ; but Fear, according to the different Respects and Considerations of the Object by which it is rais'd and impress'd, has very different and even contrary Effects.

WHERE the Desire of any Good is join'd with the Apprehension of the greatness and excellency of the Thing desir'd, and the impossibility of obtaining it, the Passion of Fear thus arising, is always mix'd with an unconsolable Grief, and so runs into Despair : and this being almost perfectly the same thing with that Species of immoderate excessive Grief already describ'd in its Nature and Consequences, what has been observ'd there, may

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may be here also equally understood and apply'd.

BUT when the Fear arises from some imminent Danger, or apprehended present Destruction, and is at the same time attended with the hope or appearing possibility of escaping the threatening impending Danger, or destructive Evil, the Passion of Fear thus rais'd and impress'd, is the strongest and most amazing of all the rest; for this impresses the greatest possible Energy and stimulating Force upon the Nerves, insomuch that a Man's Strength, Activity, and capacity of Motion, under any such sudden emergent Consternation or Fright, enable him to do things that are perfectly stupendous, and in a manner incredible. Every body knows how much the Actions of People on a sudden Surprise, exceed their natural Strength and Ability, or ordinary power of acting; for in this case the Desire of Self-preservation is impress'd, in the strongest and most forcible manner possible; and the Effects are answerable, and proportional to the Force and Energy of the motive *Stimulus*.

IT may be here observ'd, that the prodigious Strength, or surprizing muscular Force and Energy of Mad-men, is owing to this Passion habitually and mechanically fix'd upon them, so as to prevail over all the power and command of Reason; for the ravingly Mad are always in a Fright, every body looks ghastly and formidable to them, they are possess'd

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possess'd with a deep severe Suspicion that all about them intend them Mischief, and wait but for an opportunity to destroy them; and therefore they rush upon any that come near them, or endeavour to take them upon a proper advantage and surprize, to cut them off, as apprehending it of absolute necessity for their own Preservation and Security: and therefore the Force, Resolution and Hardiness of Mad-men, proceed not from true Courage, but from the utmost height and extravagancy of Fear, and a wrong Impression or Imagination of imminent Danger and inevitable Destruction, which renders them desperate: but when they are once thorowly subdu'd, and find themselves under a superior Strength, they soon discover their predominant Passion, for they will then quake and tremble, beg and submit in the tamest and most abject manner; and manifest all the Symptoms of an horrible and unconquerable Fear, which bears down and prevails over all the power and command of Reason.

FROM this account of the sensible Appearances or Phænomena of these Passions, or different Modifications of Desire, the Nature and Mechanism of these and all the rest may easily be accounted for and explain'd; to which purpose I shall here farther premise the following general Phænomena, as matter of Fact and Observation.

#### I. ALL

I. ALL the grateful or pleasurable Passions raise the vital Tide, strengthen and quicken the Pulse, diffuse the natural Heat, and take off any antecedent *Stimulus*, Weight, or Pressure upon the Abdomen and inferior Organs: but on the contrary, the painful Passions sink and depress the Blood, weaken the Pulse, recall and concenter the natural Heat, and fix a *Stimulus*, Weight and Compressure upon the inferior Organs.

II. ALL the Passions impress their characteristic Sensations or Modifications of Pleasure and Pain, especially upon the *Oesophagus* and upper Orifice of the Stomach.

III. ALL the Passions discover themselves by the different Modulation and Tone of the Voice, or the different Modifications of Motion which they impress upon the Muscles of the Larynx.

IV. THE Passions also fix their characteristic Symptoms and Appearances in the Motion of the Eyes, the Air of the Countenance, and the Muscles of the Face.

FROM these Observations it may be concluded, that the Nerves of the eighth Conjugation, or the *Par vagum*, are the principal Instruments of the Passions, by means of which they are variously impress'd, modify'd, and organiz'd: to make this appear, we need only to consider the remarkable Distribution and Communication of those Nerves, together

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ther with the necessary Consequences of their different Impressions, and determinate Modifications of Motion; and then to apply this to the foregoing Phænomena of the Passions, by which they will be most easily and naturally explain'd.

'TIS well known to the Anatomists, that these Nerves take their original, together with nine other conjugate Pair, from the *Medulla oblongata*; the *Par vagum* having perforated the *Os occipitis*, sends out Branches to the Pharynx and Larynx, with their several Muscles; after which, in its progress, it is dispersed thro' all the parts of the Breast and Abdomen, and particularly it dispenses Sense and Motion to the Heart, Lungs, *Oesophagus*, Stomach, Diaphragm, Intestines, Liver, Spleen, Mesentery, Caul, Kidneys, and Bladder, and to the several Organs of Generation in both Sexes. But because the Branches and Ramifications of the *Par vagum* could not have dispensed sufficient Sense and Motion thro' such a large and wide Course to so many complicated Bowels and Organs; therefore there is another Nerve form'd after an extraordinary manner, and which may be justly esteem'd the great Accessary or Assistant to this eighth Pair, or *Par vagum*: what I here mean, is the intercostal Nerve, which has no particular distinct origination, either in the *Medulla oblongata*, or the Spinal Marrow, as all the other Nerves have, but is thus form'd. First, several Branches proceeding from the fifth,  
C c sixth,

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sixth, ninth, and tenth Pair of the *Medulla oblongata*, uniting with other Branches and Ramifications from the *Par vagum*, constitute this Intercoastal, which afterwards in its progress downward, is reinforc'd with a multiplicity of small Branches from the vertebral and intercoastal Nerves, which are sent out from the Spinal Marrow. The Intercoastal thus formed, accompanys the *Par vagum* thro' its whole Course, and sends out Branchings and Ramifications, together with those of the eighth Pair, to all the Parts and Organs above mention'd.

Now by this means the *Par vagum* communicates not only with the Nerves which proceed from the Spinal Marrow, but likewise with those which are the Organs of Sensation in the Brain, and which communicate Sense and Motion to the Eyes, Ears, Tongue, and Palate, and to the several Muscles of the Face, by which the Passions are naturally characteriz'd and express'd. I shall therefore call the *Par vagum*, with its several Branches and Ramifications, the Patheticks of the *first Order*; the Intercoastal, under all its Divisions and Subdivisions, which are every where disseminated and interspers'd with the Branches of the *Par vagum*, the Patheticks of the *second Order*; the Nerves which serve the Muscles employ'd in Respiration, and which have the strongest Communication with those of the *Par vagum*, by means of the Intercoastal I call the Patheticks of the *third Order*; and the

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the Nerves which immediately dispense Sense and Motion to the several Parts of the Head, and which have a weaker and more remote Communication with the *Par vagum*, by the mediation of those Branches of the fifth, sixth, ninth, and tenth Pair, which join the Intercoſtal, I call the Patheticks of the *fourth* or laſt Order.

ACCORDING to this Gradation, the Organs which are immediately ſupply'd with Nerves from the *Par vagum*, or Patheticks of the firſt Order, will be firſt affected in the Paſſions, and with the leaſt degree of impreſs'd Motion; with which the Organs communicating immediately with the Intercoſtal keep pace, and are affected almoſt at the ſame time, and with the ſame impreſs'd Motion: in the next place, the Organs which are ſupply'd with the Patheticks of the third Order, or the Nerves employ'd upon the Muſcles of Reſpiration, are affected; and laſt of all, the Organs of Senſe and Motion in the Brain itſelf, by which Senſation and Imagination are perform'd, are put into a ſtrong and forcible Emotion, by which the Operations of Senſe, Judgment, Imagination, and Reaſon are diſturb'd, and perverted in the ſtronger and more violent Paſſions. This gradual riſe and progreſs of the Paſſions, is confirm'd in fact by Obſervation and Experience; but how they are generated, and by what ſteps they make theſe advances, muſt be conſider'd a little farther.

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IT must be here then observ'd, that the quantity of Motion impress'd upon the Pathetick Nerves in any Passion, is always proportional to the strength of the Desire; that is, to the apparent greatness and necessity of the Good which we desire to obtain, or continue the Enjoyment of: or, which is the same thing, the quantity of Motion impress'd, is ever proportional to the greatness and destructiveness of the Evil which we would guard against, or get rid of; for to get rid of any present, or guard against any future apprehended Evil, is a Good, in proportion to the greatness of the Evil that is remov'd or prevented.

BUT such impress'd Motion is not always uniform, or equably communicated and diffus'd thro' the whole pathetick System; for since the largest and most numerous Branches and Ramifications of the pathetick Nerves are spent upon those Organs, which derive their Blood from the descending Trunk of the *Aorta*, as the Stomach, Intestines, Liver, Spleen, Mesentery, Pancreas, Kidneys, &c. upon any Motion too forcibly impress'd, or long continu'd, these inferior Organs are generally the first and greatest Sufferers: for these inferior Branches and Divisions of the pathetick Nerves, being larger and more numerous than those above the Heart, 'tis plain they will be capable of receiving and retaining a greater quantity and degree of Motion, which in the stronger and more violent Impressions

pressions of the Passions, must break and interrupt the *Æquilibrium* of the circulating Blood: and the Blood flowing with impetuosity, and in Fluctuations and irregular Surges to the stimulated Parts, those Organs which are thus over-stretch'd and distended, must undergo a Sense of Pain, Weight, and Oppression; and by this means the Head and superior Parts being depriv'd of their due share and proportion of Blood, the Pulse must sink, the natural Heat diminish and retire, a Sense of Cold and Constriction will be felt about the *Oesophagus*, where the Branches of the *Par vagum* are very numerous, and the Person will sigh, groan, moan, cry out and complain, and discover in the Tone of the Voice, and Modulation of the Muscles of the Larynx, the characteristicks of the prevailing Passion.

THIS is the state of Nature under the painful depressing Passions, which arise from a strong Desire, join'd with an appearance of Improbability, great Difficulty, or Impossibility of obtaining or securing the Good desir'd; but where the Desire is attended with an appearance of Probability, or facility of obtaining or effecting the thing desir'd, this pleasing appearance of Probability, by moderating the Pain of the Desire, and taking off the too great and violent Action of the pathetick Nerves upon the inferior Organs, will throw the whole pathetick System into a strong, but easy, natural, equable, and uniform

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form Undulation ; by which the *Æquilibrium* of the Blood being restor'd, the invigorating pleasurable Passions of Love, Joy, Hope, &c. will be rais'd : and in this case the Pulse rises, the natural Heat is diffus'd ; and by the Action of the pathetick Nerves upon their proper and respective Organs, the several Symptoms are produced, which discover their placid Emotion, under the agreeable Appearance of the Object.

BUT the strongest and most universal Impression of Motion upon the Nerves, arises from some extremely keen and sharp Desire, join'd with the Appearance of probable Success, under the necessity of acting for Self-preservation, or to avoid some apparent or apprehended present Destruction. The prodigious and surprizing Force or Energy which a strong stimulating Desire under these Circumstances impresses upon the Nerves, would be altogether incredible, were we not sufficiently convinced of it from the Actions of Mad-men, and of People in a Fright.

IN this case the *Stimulus* of Desire being exceeding strong, and the consequent impress'd Motion universal, the pathetick Nerves of the fourth and last Order come to be affected ; that is, the Organs of Sensation and Imagination in the Brain are brought into such strong and violent Vibrations or Undulations, as to disturb and pervert all the Operations of Reason : for, from this violent Perturbation of the pathetick Nerves in the Head and Brain,

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Brain, Mad-men have their Imagination as strong and vivid as Sensation itself; what they imagine, they see and hear; and the Impressions are equally strong, and the Appearances the same, as if their Organs were immediately struck by the Objects themselves: they who contradict them, or endeavour to convince them that the Objects of their Imagination are not real, seem as absurd and unreasonable to them, as if they call'd in question the truth of their Senses, or deny'd the existence of present visible Objects; and for this reason they generally hate most their best Friends, and such as they had the greatest respect for before, because they endeavour to persuade them out of their imaginary, and to think and act upon common Principles, which yet is impossible. In the mean while, this strong and deep attention to the Objects of their Imagination, takes them off from what is really existent and about them: they see and judge of nothing as it really is, or as other Men do, but every thing looks new and odd, strange and surprizing to them. In short, by the strength of their Passions, their Imagination prevails over their Senses; and perhaps the State they are in, cannot be better describ'd, than by calling it a waking Dream: for when they recover, they look back upon what pass'd in their Madness, as a Man when he awakes reflects upon the Images and Representations of his Dream.

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FROM these violent efforts of the Sensorys and motive Organs in the Brain, the Blood flows continually with impetuosity and irregular Surges to the Head, and is again thrown off as fast by the strong and forcible Action of the Nerves. This Emotion and Perturbation being maintain'd by the continued *Stimulus* of the Passions, and strengthen'd and confirm'd by the Heat and Efflatus of the Blood in the carotid and cervical Arterys, the vital Tide is by this means raised, and incessantly kept up against the weaker Efforts of the inferior Organs below the Heart: and from hence it comes about, that Mad-men do not need those periodical returns of Sleep and Rest, to raise and recover the *Æquilibrium* of the Blood, which are necessary to others: but on the contrary, they can watch almost continually, bear the extremes of Heat and Cold, and undergo the most violent Efforts of continued Motion, without any Sense of Pain, or being at all depress'd, dispirited, or fatigued.

Now from hence we may observe the two contrary Extremes of the invigorating and debilitating Passions; the one rising up at last into a *Mania*, or raving Madness, and the other sinking into a hypochondriack Melancholy: the principal Seat of the one is the Brain, and of the other the Viscera of the Abdomen, especially the Spleen and Mesentery. The one inflames and over-heats, the other chills and frosts the Imagination: the one hangs over the Understanding like a glaring,

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ring, dazzling, infatuating Light, which darts like flashes of Lightning thro' the Machine; the other like a thick, black and dismal Cloud, that sinks all the Powers of Nature into the Depths and Horrors of Misery and Despair.

FROM what different Impressions and Modifications of Motion upon the Nerves, these two opposite Constitutions of raging Madness, and hypochondriack Melancholy are produced, will be easily understood by what has been said already; but it may be of consequence here to observe their different Effects, by a long continuance upon the Organs, and the Diseases they at last produce, by which the Passions, to which they owe their original, are farther strengthen'd, radicated and confirm'd.

Now the Blood having been long depress'd, and determin'd with too great an Impetus and Weight downward to the Viscera of the Abdomen; these Viscera by an Over-stretch and Distension, must at last come to be obstructed, tumefy'd and ulcerated by a thick, salt, viscid and coagulated Lymph, or Serum lodg'd upon the Glands: that is, those Organs will be affected with a fix'd, confirm'd Scurvy. In which case, tho the Spleen and Mesentery generally suffer first, yet the other Viscera, particularly the Liver, Caul, Pancreas and Kidneys, often share their Parts, and come to be affected after the same manner. Now by such a *Stimulus*, which must be occasion'd by the tumefy'd, indurated, or ulcerating Glands in these Viscera, the Blood must be continually de-

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depress'd, and the vital Tide kept low, which must farther fix and strengthen all the painful debilitating Passions, and confirm the Habit. And indeed, from this Cause alone, the hypochondriacal Melancholy is often produc'd, without any antecedent Irregularity or Disorder of the Passions to bring it on: these Constitutions therefore mutually generate, strengthen, and nourish each other.

IN like manner, the exorbitant Passions and mental Perturbations of the other Class, which too highly raise and exalt the Blood, and terminate in Madness, come at last to fix the same scorbutick Taint upon the cerebral Glands and Lymphatics of the Brain; and then the *Stimulus* of the Passions having this additional material *Stimulus* of an hot bilious Serum fix'd upon the lymphatick Glands, the same pathetic Outrage will be hereby farther strengthen'd, and the Madness confirm'd. And in this case also the mental *Stimulus* of the Passions, and the material scorbutick *Stimulus*, will mutually generate each other: for as Madness brings on a cerebral Scurvy, which without seasonable help at last kills; so a cerebral Scurvy produces a true and real Madness, without any antecedent Disorder in the Mind.

FROM the Principles already laid down, all the foregoing Phænomena of the Passions, with any other that might occur to Observation and Experience, might easily be accounted for in particular; but that would draw

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draw out this Proposition to an unreasonable and unnecessary Length, and I doubt not but the intelligent Reader will easily apply what has been said in general to the particular cases to which it may belong : and therefore I shall only add farther a few general Corollarys from what has been here advanc'd, by which the Doctrine of the Passions may be render'd more universally useful, so far as it relates to the Province of Physick.

I. F R O M what has been observ'd, 'tis plain that People of the softest and most delicate Constitutions, and such whose Nerves are most easily impress'd, and which are most susceptible of Motion, must be chiefly subject to the strength and violence of the Passions : and therefore Women and Children are generally more subject to Passions than Men ; and they exert their Rage and Tyranny upon Men, in proportion to the tenderness of their Constitutions, and the weakness of their Judgments. But they who have the care and management of Children, ought especially to guard them as much as possible against the Attacks and Impressions of the Passions : for tho the Passions may seem innocent and diverting at first in Children, before they have strength or skill enough to do much harm with them ; yet by growing up with them, fixing their Characteristics and Impressions upon the Constitution, and being sown as it were in the first Rudiments of Nature, they still gain strength with years, and soon become infinitely mischievous.

2. F R O M

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2. FROM hence we may see, that a sound Mind, a clear Head, and a well-settled Judgment, a just Acquaintance with human Nature, and a right Notion of human Life, are the best guards and defence against the hurtful destructive Passions: for the Passions being constantly and universally in all their Modifications, whether good or bad, annex'd to the several Judgments we form concerning Good and Evil, 'tis certain they are never injurious, hurtful or mischievous, but when they proceed from a wrong Judgment. The wretched Mistakes which Mankind are apt continually to run into, concerning Life, Pleasure and Happiness, are undoubtedly the true ground of all the exorbitant Passions and their destructive Consequences: a Man, without being over-religious, might be easily convinc'd that Pride, Ambition, Malice, Revenge, Avarice, Sensuality, and the like vicious irregular Desires, can never be quieted or tamed by Gratification; they are always strengthen'd, fed and nourish'd by their Objects, till the predominate Passion becomes an absolute uncontrollable Master, and destroys a Man's Reason, Judgment and Health, together with his Virtue. Nothing can lay these evil Spirits, or appease their Vengeance, but a resolute Self-denial, by keeping the Passions continually under the Curb and Restraint of Reason; and a Man is never hurt by them, till he sacrifices his Understanding, and gives himself up to the Pleasures and Happiness of a Beast or a Devil.

BUT

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BUT among all the exorbitant Passions, that Rage, Fear and Grief, which enter into the Constitution of Superstition and false Religion, are the most hurtful and destructive to the particular Persons themselves, as well as to Mankind in general. All Impostors have been ever sensible of the Power of Fear in Religion, and have contrived their Systems accordingly; Vengeance without Mercy, inexorable Revenge to be executed upon all Adversarys and Gainfayers, as it is the Character of a Being perfectly cruel, mischievous, and wicked, so it is the Image in which all Impostors have ever affected to dress up and represent their Deity: and from hence it happens, that they who are once thorowly devoted and enslav'd to any such Scheme of false Religion or Superstition, presently lose their Understandings, and become Maniacks or Hypochondriacks: 'tis their business to fight in the dark, and to kill and destroy themselves and one another, to gratify the Malice of their God, and complete the Merit of their Divinity. Such a Religion, whatever its Pretence be, is most certainly Diabolism; and the God that Men worship by Rage and implacable Revenge, under the grievous Fears and Apprehensions of his Power only, without Wisdom or Goodness, is no other than the Devil.

3. WE may conclude likewise, from what has been here observed and advanced, that nothing is more necessary to keep the Passions under the Moderation, Government, and Com-

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Command of Reason, than continual Employment and Exercise, in the pursuit of some great, generous and virtuous End: by this alone a Man will be capable of answering the design of his Being, and of securing to himself all the innocent and valuable Pleasures and Enjoyments of Nature. All the Passions come with their full force upon the Idle, as having nothing to divert or bear off the blow; but when they find a Man otherwise employ'd, they miss their mark, and either never affect him at all, or strike him but weakly, at random, and with a force that is easily diverted another way. In short, Business is the true Elixir of Health, for the Mind as well as for the Body, and one of the greatest and most sovereign Preservatives against destructive Passions and Diseases.

*The End of the SECOND PART.*



*Philoso-*



# *Philosophical Principles*

O F

# M E D I C I N E.

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## P A R T III.

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Containing the primary and chief Intentions of Medicine in the Cure of Diseases, Problematically propos'd and Mechanically resolv'd.

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### PROPOSITION I.



*To explain the morbidick Constitutions, as depending on the different State and Disposition of the Blood.*

*THE Blood differs in different Persons, and in the same Person at different Times, with respect to its Quantity, Velocity, Fluxility, Density,*

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*Density, Serosity, Solubility and Direction, or particular Determination.*

'TIS difficult to determine exactly the absolute quantity of Blood in a human Body; but 'tis certain that this Quantity must be much greater than has been commonly supposed, and that all the Trials made by bleeding several Creatures to death, and computing the quantity of Blood in other Bodys, in proportion to the Weights, must be fallacious: for 'tis probable that at least  $\frac{2}{3}$  of the quantity of Blood contain'd in an animal Body, is continually passing the Capillarys and small Vessels in the glandular and muscular Flesh: and this Blood can never be drawn off by any quick Discharge from cutting the large Vessels, for in this case, the large and open Vessels are empty'd faster than they can be supply'd, and fill'd again from the capillary and small Vessels; and the large Vessels being empty'd, from the consequent Defect of Blood at the Heart, the Animal falls into Convulsions and dies, and the Circulation stops, while the far greater Part of the Blood must be suppos'd to stagnate in the small Pipes and Capillarys.

BESIDES, it cannot be doubted but the natural and due quantity of Blood is very different in different Constitutions, and under the various Circumstances of animal Life. Women and Children have proportionally more Blood than Men; and in general, the more soft, delicate, and tender the Constitution,

tion, the greater is the quantity of Blood and Fluids in proportion to the Solids.

BUT this is a Speculation of no great consequence : for tho the absolute Quantity is hard to be determin'd, yet the relative Quantity, as redundant or defective, may easily be discover'd ; and this is all that the Physician is concern'd about. And here the Symptoms of Excess or Defect, of an Over-repletion or Depletion in the Blood-Vessels, are so very obvious, that they need not particularly be insisted on ; only one thing it will be necessary to remark, that a Physician ought to be very cautious that he does not mistake every occasional Flush or Tide of the Blood to the Head, for a general Plethora of the Blood-Vessels : for these Tides and Flushings are very common in many cases, where there is yet no Blood to spare ; and in which whenever Bleeding is hastily resolv'd upon, it is certainly attended with future ill Consequences, much greater than the present Benefit receiv'd.

THE morbifick Excess, or Defect of the Blood's Velocity, is as remarkable as that of its Quantity ; but this can only be judg'd of from the natural state of the Pulse in Health, which is different in different Constitutions : the ordinary number of Pulsations in a Minute, is from 70 to 80, under a state of Waking and moderate Heat ; and from 80 to 96, during the time of Sleep.

THE Velocity of the Blood (to which its *Momentum* is proportional) is ever in a Ratio

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compounded of the frequency of the Pulse, and the magnitude or quantity of the Stroke: and consequently when the number of Pulsations in a given Time, and the quantity of the Stroke are reciprocally proportional; or where one is increas'd as the other is diminish'd, the Velocity will remain the same. 'Tis well known that a certain Quantity of Blood thrown into the Arterys at every Systole or Contraction of the Heart, occasions the Pulse: now this quantity thrown into the Arterys at every Contraction of the Heart may be greater or less, while the number of Pulsations in a given Time, or the frequency of the Pulse continues the same: from whence 'tis evident, that the Blood may move swifter or slower thro' the Vessels; that is, the Velocity may be greater or less, while the number of Pulsations is the same. But tho the distance between the Pulsations may not be alter'd, yet the magnitude of the Stroke or strength of the Pulse, must necessarily be proportional to the quantity of Blood thrown into the Arterys; by which the Sides of their Vessels are driven outward, and which is the only cause of the Pulse. On the other hand, where the quantity of Blood thrown into the Arterys at every Systole continues the same, the absolute Quantity passing in a given Time, must be proportional to the frequency of the Pulse, or the number of Pulsations in the Time given: and therefore the absolute Velocity must be proportional to both these conjunctly, or in the  
Ratio

Ratio compounded of the frequency of the Pulse, and the magnitude of the Stroke.

IT is therefore a great mistake in those who judge of the Velocity of the Blood only by the frequency or quickness of the Pulse, as if a quick Pulse always indicated an increas'd Velocity, and *vice versa*; and consequently they have been much mistaken, who have defin'd a Fever by an increas'd Velocity of the Blood: for nothing can be more manifest to Experience than this, that the Velocity of the Blood may be increas'd extremely without a Fever; and on the contrary, this Velocity, during a Fever, is often very much diminish'd, as appears from the weakness of the Pulse, tho' it may be very quick, and even tremulating.

THERE is one very remarkable difference of the Pulse, which it may be necessary to observe here; and that is the Distinction between a large or full, and a thin or small Pulse: either of these may be strong or weak, and by a reciprocal Proportion may so balance each other, as to retain the same magnitude or quantity of the Stroke in both; that is, the Velocity of the Blood under a large, full, and weak Pulse, may be the same as under a small, but strong and smart Pulse.

THE Coats of the Vessels being sometimes very much distended by the great quantity of Blood thrown into the Arterys at every Systole, the Pulse hereby becomes slow, and the Blood waves or undulates thro' the Vessels, in a full, swelling, but slow Tide. This is commonly

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the lethargick and apoplectick Pulse ; and the same kind of Pulse discovers itself in the pleasurable Passions, especially those of Love and Joy, when very strong and sensible ; and in a very sudden excessive Emotion of Joy, the Pulse rises and swells extremely, and then sinks all at once, and the Person sometimes expires in a *Deliquium*.

ON the other hand, a very thin and small Pulse is often extremely smart and strong, and the Blood is driven swiftly forward, while the contractive Power of the Nerves is very great, so as to resist any great Distension or Enlargement of the Blood-Vessels : and this sort of Pulse may generally be observ'd in Mad-men, and in those who acquire an extraordinary Strength and Activity, when made desperate by a Fright, or set upon Action by the appearance of some present pressing Necessity for Self-preservation.

3. ANOTHER different State or Disposition of the Blood, is its greater or less degree of Fluxility and Viscidity : 'tis manifest that the Blood, on the one hand, may have its parts too intimately separated, divided, attenuated and fluxiliz'd ; or on the contrary, there may be a too strong and close Cohesion of the Parts of the Blood, so as to render the Mass extremely thick, viscous, and tenacious. The first of these morbidick Constitutions disposes the Blood to a too quick, easy, and rapid Motion, and sometimes dissolves and fuses it to such a degree, that the Globules or *Cras-*  
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*famentum* passes together with the Serum thro' the glandular Strainers, and occasions bloody Secretions, as in malignant and pestilential Fevers: but the other viscid cohesive state of the Blood, renders it unapt for Motion, and disposes it to stick and lodge upon the Capillarys, and glandular Lymphaticks or Aqueducts.

4. ANOTHER different State or Constitution of the Blood depends on its specifick Gravity, or the various degrees of its Rarefaction and Condensation. This Constitution depends intirely on the several degrees of Heat in the Blood; for as the natural Heat rises too high or sinks too low, the Blood will in consequence be either too much rarefy'd or too much condens'd: and the consideration of this is of such importance, that a Physician can do nothing as he ought without it. For in the former case, where the Blood is overheated and rarefy'd, the expansive Force of the elementary Fire and Air contain'd in the Mass, prevails over the corpuscular Attraction; and then by the coagulating Power of Heat upon the Serum, and its too intimate Mixture and Cohesion with the *Crassamentum*, the Lymph which should form the Secretions, cannot be separated, but the Serum is as it were absorb'd, imbib'd, or suck'd up in the *Crassamentum*; in consequence of which, the natural Secretions must necessarily be diminish'd.

NOW in this case, if the expansive Force of the heated rarefy'd Blood be too strong for the contracting restitutive Power of the Nerves, as it usually happens, this must break and destroy the *Æquilibrium* of the circulating Blood; and the *Æquilibrium* being thus broken, and the lymphatick Secretions at the same time extremely lessen'd, or quite suspended, a Fever must ensue, of some sort or other, and more or less inflammatory, according to the degrees of Heat in the Blood, and consequent Suspension or Interruption of the lymphatick Secretions. But if by means of some violent Passion, or other *Stimulus* upon the Nerves, their contracting restitutive Power is kept up and maintain'd, so as sufficiently to resist the expansive force of the heated rarefy'd Blood; the Lymph in this case will pass off in a greater Quantity, tho in a Quantity less than what is natural, the consequence of which will be a *Mania* or Madness, which is Phrensy or Delirium without a Fever.

THE opposite Constitution to this, is where the Blood is immoderately cool'd and condens'd; in this case, the corpuscular Attraction prevails over the expansive Force, and the Serum hereby being over-thinn'd and fluxiliz'd, is separated too fast, and thrown off in immoderate Quantities upon the Glands and Lymphaticks: now from hence, if upon any occasion the urinary Drains happen to be obstructed, a surcharge of Serum upon the Glands and Lymphaticks must soon be the consequence,

quence, and a Dropsy will ensue. But in case the fluid Parts of the Urine pass freely enough, and only the grosser Recrements, Salts, and Sabula are kept back; these, being thrown upon the several Organs, sometimes in one Part and sometimes in another, will produce the several Symptoms and Appearances of the Scurvy; which morbid Constitution having been consider'd already, *Prop. 13. Part II.* I need not farther insist on it here. And how this morbid State may raise and bring on the several Species and Phænomena of scorbutick or glandular Fevers, has been already, as I presume, at least sufficiently explain'd.

FROM all which I may make this general Observation; That 'tis a thing of great consequence to a Physician, not only in Fevers but in all other Diseases, to watch carefully the various Turns and Interchanges of Nature with respect to Heat and Cold, upon which the present state and disposition of the Blood, as to Rarefaction or Condensation, will depend; and as one or the other of these shall happen to prevail, whether constitutionally or by accident, so the general Method ought accordingly to be either cooling, refrigerating and condensing, or warming, raising, and invigorating. But,

5. THE State and Constitution of the Blood differs also with respect to its Serosity and Oleosity; that is, with regard to the different quantity and proportion of the Serum and *Crassamentum* in the mix'd Mass.

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THE *Crassamentum* which subsides in the Porringer when Blood has been drawn off, is generally  $\frac{1}{2}$  of the whole Mass, or equal in Quantity to the Serum which swims above it; this is its most natural and ordinary Quantity, and where it is found in a proportion very different from this, whether in Excess or Defect, the Constitution becomes morbid. And because the principal Heat, Vigour and Efflatus of the Blood consist in the *Crassamentum*, by reason of the great proportion of Oil and volatile Salts with which it abounds; therefore from the proportion of the *Crassamentum* to the Serum, the heat of the Constitution may be judg'd of: which is either greater or less, excessive or defective, according to the greater or lesser quantity and proportion of the *Crassamentum* in the Blood. 'Tis true indeed, that where the quantity of the *Crassamentum* in proportion to the Serum is very great and excessive, and but little Serum will separate from the Blood by long standing; the Constitution will be weak, and all the animal Powers low and languid: yet still a continual troublesome Heat, great difficulty of Breathing, and hot, suffocating, inflammatory Pains coming on by any little Motion or Exercise, will be the constant Symptoms and Indications of such a state and disposition of the Blood.

ON the other hand, an excessive quantity of the Serum, in proportion to the *Crassamentum*, brings on, or disposes to all those Diseases

eases which are attended with a sinking, languid, debilitating coldness of Constitution.

6. BY the solubility of the Blood, I understand that *Quality* or *Tendency* in the Serum and *Craſſamentum*, by which they are disposed to separate and disengage from each other, when the Blood comes to stand and cool in a Basin or a Porringer. 'Tis well known that when Blood is taken off, it must frequently stand a long time at rest, and in a cold place, before its Principles can disunite so as to effect a perfect separation of the Serum from the *Craſſamentum*; and yet at last, when the Separation is made, there may be a sufficient quantity of Serum, and perhaps a greater proportion than ordinary; whereas at other times, this Separation shall be quickly made, and the Solution effected after a short time of standing and in a warmer Air.

EVERY one must have observed these different Phænomena in the Separation or Solution of the Serum and *Craſſamentum*; and the principal reason of this difference, is plainly the different Degrees of Heat to which the Blood is subject, the Globules being much more rarefy'd and expanded at one time than at another: and therefore as the arterial Blood being hotter, is longer in effecting this Separation than the venal; so in a high inflammatory Fever, the venal Blood requires a considerable time of standing in a cool place, before it can throw off its Serum: but in a cold condensative State and Disposition of the Blood,

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Blood, this Separation or Solution is procured almost presently ; for 'tis plain that the more the Globules are heated, expanded, and enlarg'd, the nearer they will come in specifick Gravity to the Serum, and consequently retain any given Position in it : besides, the greater the expansive Force is which has been impress'd upon these Globules, the more the corpuscular Attraction of their Parts must be resisted and retarded, which must resist and retard their Union, Cohesion and Subsidence.

FROM this difference therefore in the Separation or Solution of the Serum and *Crassamentum*, the different Proportions of the expansive and attractive Forces, and consequently the different state and degrees of the natural Heat, in Fevers and other Diseases, may be rationally determin'd and judg'd of : and this shews of what consequence it is to a Physician, in most cases, to take at first a little Blood, that he may be enabled to judge of its State and Constitution, whether there be any other occasion for Bleeding or not ; for as this can do no harm, so it may often be of great use.

THERE is, however, another partial cause of this different Solubility in the Blood, besides the different Degrees of its Heat and Rarefaction, and that is the different proportion of the Serum to the *Crassamentum* : for where the Serum bears but a very small proportion, it will cohere the more strongly with the *Crassamentum*, and be separated with the  
greater

greater difficulty. Besides, where there is but a small quantity of Serum, it will be strongly tinged with the Oils and Salts of the *Crassamentum*, which will render it nearly of the same specifick Gravity, and consequently retard or hinder its Separation. But indeed, where there is this abounding of the *Crassamentum* in the Blood, there is for the most part a proportionally abounding Heat; and therefore this case is almost coincident with the former, tho not perfectly the same.

7. THE Consideration of the different Directions, or determinate Motion of the circulating Blood, is a matter of great consequence: for tho the Blood continually circulates, and is dispens'd from the Heart thro' the Arterys to all the Parts, yet a Man would be very much mistaken, who should imagine that all the Parts and Organs to which the Blood is dispens'd continually, receive their due proportion and share, and that this Circulation is always equable and uniform. All Physicians know to what great Irregularitys the Blood is liable in its different Direction and Determination; and enough has been said already of that great, general, and most remarkable difference in Motion and Direction of the Blood, with respect to its occasional and various Afflux or Reflux to and from the Head. Any considerable *Stimulus* will derive the Blood in larger quantitys to the stimulated part, which must break and interrupt the *Æquilibrium* and Uniformity of its Circulation: and from hence it comes

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comes about, that a great part of a true and regular Practice, consists in deriving, revulsing, and variously directing and determining the Blood, in order to recover its *Æquilibrium* and due Circulation.

THESE are the several Appearances and Phænomena which chiefly come under the consideration of a Physician, with regard to the various and different state, constitution, texture and disposition of the Blood; and as these are all sensible Qualitys, their Effects must be accordingly great and sensible.

FROM the several prevailing Compositions, or Combinations of these Qualifications and different Dispositions of the vital Fluid, various compound Constitutions will arise, requiring a different Method and Procedure: thus for instance, either a hot and rarefy'd, or a cool condens'd state of the Blood may be attended with great viscosity and tenacity of the Parts, or on the contrary with an immoderate fluxility and tenuity; in which the natural cohesive or balsamick Quality of the Blood may be lessen'd, and in a great measure lost. And from hence there will arise four different Constitutions, the observation and right understanding of which, will be of great consequence; namely, a rarefy'd Viscidity, and a rarefy'd Fluxility; a dense Viscidity, and a dense Fluxility. The farther Consideration of which, and their different Consequences, will fall under some of the following Propositions.

PROPO-

PROPOSITION II.

*TO cool, dilute and attenuate the Blood.*

THE too great heat and viscosity of the Blood, is one of its most generally prevailing morbid Constitutions ; especially in such a Country as ours, abounding with all the Temptations to, and Provisions for Ease and Luxury ; for this morbid state of the Blood is certainly brought on for the most part by drinking too freely of hot, spirituous, inflammable Liquors, and feeding plentifully on things which contain a large Proportion of volatile oily Salts ; such as flesh Meats half boil'd or roasted, eaten in their red bloody Gravy, and all hot, spicy and high-season'd Broths, Sauces or other Foods.

THE Blood being thus over-heated and rarefy'd, the Serum is in consequence thicken'd, coagulated and turned into a sort of Gelly ; by which means it must be render'd unfit for Motion, cohere too strongly with the *Crassamentum*, and pass but slowly thro' the Lymphaticks and glandular Strainers.

IN this State and Disposition of the Blood, the thicker and more viscid Parts of the Serum must needs lodge upon the Lymphaticks and common Receptacles of the Glands, till they are gradually fill'd up, obstructed, tumefy'd, and preternaturally distended. From which gradual obstruction of the Glands, and diminish'd or intercepted circulation of the animal Fluids,

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Fluids, the heat and viscosity of the Blood still increase, till the vital Flame raised too high, is suddenly extinguish'd in the cold Embraces of Death.

THIS morbid state of the Blood, and all its evil Symptoms, are exceedingly heighten'd and aggravated by a sedentary Life, or the want of sufficient Motion and Exercise. For while the natural Action of the muscular *Fibrillæ*, is either not at all or but little assisted and promoted by voluntary Motion, the Glands and their common Receptacles must be the sooner stuffed up and obstructed; and the Circulation of the Lymph, that great and powerful means by which Nature continually cools and dilutes the Blood, will in a short time be suspended. By this interrupted Circulation of the Lymph, the natural Heat being rais'd too high, a Fever will ensue; which after such a general and obstinate obstruction of the Lymphaticks must prove incurable.

FROM this account of the Causes, 'tis evident that Temperance and Exercise must be necessary and essential to the Cure. No Medicines can be of much use where a Man will not govern his Appetites by Reason, and employ the Powers and Instruments which God has given him for Exercise and voluntary Motion.

AMONG all Liquors, Water is beyond controversy the most excellent and effectual to cool and dilute the Blood, to wash off the Viscidities and obstructing Cohesions of the Glands,  
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and to keep the animal Fluids in a due state of Fluxility and Motion: and therefore this had doubtless been still retain'd as the common Drink of Mankind, had not the abuse of Reason in artificial Intemperance prevail'd so far, as to set aside one of the main Principles and greatest Preservatives of Health.

THE proper time for cooling and diluting the Blood, is in the Morning or before Dinner: for since all the expurgatory Secretions, and particularly the salival and urinary Discharges, are lessen'd during a state of Sleep; those Glands, by reason of the slower Motion of their secreted Liquors, contract a Foulness from certain Portions of a thick, viscid, or slimy Serum, left behind, and sticking or adhering to them. Now to wash off these viscid Recrements collected during the time of Sleep, diluting in the Morning is of the greatest consequence, and what ought not to be dispens'd with by those who have a just concern for their Health. To which purpose, a large Glass or two of good soft Water from marly or chalky Springs, drank first in the Morning, a Breakfast upon Water-gruel, Milk-porridge, green Tea, or some such-like cooling diluting Method, is exceedingly beneficial. If any thing stronger be taken in a Morning, the best Season for it is a little before Dinner, at which time a Glass of White-wine, or even a Draught of fine thin Ale, where a Faintness or too great Depression calls for it, may be allow'd; but otherwise it is much better omitted.

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ted. And for such as instead of this cooling diluting Method, begin in the Morning upon Drams and strong Liquors, and indulge themselves in this Practice till they have made it in a manner necessary to raise and keep up their Strength and Spirits; when Matters are brought to this pass, the best Advice that can be given a Man, is, to settle his Affairs, since his Days may be easily numbered, and his time in this World cannot be long.

WHAT has been here said, is chiefly to be understood by way of Prevention, in those who have hitherto retain'd a tolerable state of Health. But where this morbid State has been long fix'd, and deeply radicated, till the Lymphatics and glandular Recesses are strongly and obstinately obstructed by hard compact Concretions of the Serum, mix'd with the Salts and fabulous Recrements of the Blood; in this case, I say, all the cooling and diluting in the World, by any of the common Methods, will not be sufficient. Here therefore some powerful effectual Deobstruents must be made use of, such as may be sufficient to dissolve, attenuate and carry off the viscid indurated Concretions in the Glands. And to speak impartially, I know but one thing in the World that is capable of doing this with any great certainty or success, and that is *Mercury*: the milder Preparation of which, given in moderate Doses, and long continued, so as not sensibly to affect the Stomach and first Passages, nor procure any considerable sensible Evacuation, will do wonders

wonders in all glandular cases, and such as would be altogether incredible, were not the Effects sufficiently confirmed by Experience.

I KNOW it is an Opinion pretty much prevailing, that very weak People, especially the Hypochondriacal and Hysterical, cannot bear the use of Mercury; and that this Mineral being inimical to the Nerves, ought not to be given in nervous cases: but it is not yet well agreed, what Diseases are or are not truly and properly nervous. Almost all Diseases have been attributed to the irregular Motion of the animal Spirits; and all Diseases proceeding from the Spirits must, I suppose, be nervous. In the mean while, besides what has been said *Prop. 13. Part II.* it might be easily demonstrated farther, by other numerous Observations and Experiments, were it necessary, that most of those Diseases which have been peculiarly call'd Nervous, are owing to certain Obstructions, Tumors and Erosions of the glandular Organs or Bowels contain'd in the Thorax and Abdomen; and that the Matter of these Obstructions is often of such a nature, that nothing but Mercury can dissolve, attenuate and discuss it. Every body knows the egregious Power of Mercury, in dissolving and discussing the Tumors, Concretions and Indurations of the Glands, both in its outward Application and inward Use: and if we must not use the most effectual Deobstruent to remove the most obstinate Obstructions, I think we might just to as good purpose do nothing at all.

As to what is alledg'd, that Mercury is hurtful to the Nerves, I am clearly and experimentally persuaded, that this Enmity to the Nerves proceeds not from the bare Use, but from the Abuse and injudicious Management of it. For my own part, I have constantly used it in such a manner as to do no injury at least, and for the most part with good success in such chronick cases as are commonly reckon'd most peculiarly nervous. And therefore I look upon this Objection of Mercury being injurious to the Nerves, to be of no consequence at all, unless it should be thought that the Mischief ensuing from the Abuse of a thing, can be a good Argument against the right and beneficial Use of it: and indeed there are some mere Quacks, otherwise Men of no consequence at all, who yet from their Performances by Mercury in a slow, gradual way of giving it, so as not to injure the Stomach and first Passages, are a Shame to Learning and regular Practice.

THE Reason of this Effect of Mercury, as the greatest and most powerful Deobstruent, or the manner of its Operation as such, is very evident from its sensible and most obvious Qualities; namely, its Weight, Fluxility, and minute Discerpibility of its Parts, or Aptness to rarefy, diffuse and expand itself upon a small degree of Heat. And such is the extreme Discerpibility, or Minuteness of Parts into which this surprizing mineral Fluid is capable of being divided, that notwithstanding

its great Weight and Density, which is to Water as 14 to 1, yet by a small degree of Heat, it becomes as volatile and expansive as the finest Spirit or most volatile Salt. From these Property's, when Mercury is convey'd into the Blood and mix'd with the circulating Mass, it will, according to the different manner of giving it, and the different state and disposition of the animal Machine, be attended with the following Consequences.

1. WHEN it is exhibited slowly, and in small quantity's, being minutely divided, rarefy'd, and equally diffused thro' the whole Mass, it must pass off uniformly and proportionally with all the Secretions, so far as these Secretions are equally free and open, or where the Resistance is every where equal: and in this case the effect of the Mercury will be only by its greater motive Force to increase the Velocity and Moment of the Blood, and thereby to augment all the Secretions in the same proportion. But when the Resistance is unequal, the greatest Quantity must pass in a given time thro' those Pipes or Canals where the Resistance is least; which is a Property in common to this with all other Fluids.

2. WHEN Mercury is given in large Doses, or frequently repeated, so as to throw a considerable Quantity of it into the Blood in a short time, it will not be capable in this case of rarefying and diffusing itself gradually and uniformly, as where it is given slowly and in small Quantity's: but its sudden Rarefaction

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and extreme Volatility acquir'd by the natural Heat, must determine its principal Force and Efficacy upward; that is, it must rise in a strong plentiful Steam or Vapour to the Head, and be thrown off by the salival Glands: and this not only as these Glands are situated in the superior Part of the Body, to which the Mercury by a sudden Rarefaction, and before it can have time to diffuse itself, must necessarily rise; but likewise as these Glands are more free and open than most others, and continually discharging an easy flow of the Saliva.

3. WHEN Mercury is convey'd or carry'd into the Blood slowly and gradually, so as to give it time to diffuse itself pretty equably and uniformly, tho the greatest Quantities in a given time will pass thro' those Glands which are most free and open, or where the Resistance is least; yet its principal and most sensible Effects will be upon such Glands as are most obstructed, or where the Resistance is greatest. For let us suppose any particular Gland to be obstructed, with a thick, viscid and strongly cohering Matter, so that the Blood and Lymph in their natural course of Circulation cannot pass; and let us suppose at the same time this circulating Blood and Lymph to be replenish'd and diffus'd with a certain Quantity and Proportion of Mercury: then 'tis plain, that the Mercury contain'd in and diffus'd thro' the Blood and Lymph, being indu'd with a greater *Momentum Motus*, and a stronger corpuscular Attraction, by reason of the Smallness and  
Density

Density of its Parts, will pass where the Blood and Lymph cannot: and consequently the Mercury, by its greater moving Force and stronger corpuscular Attraction, will penetrate into the viscid cohering Matter of the obstructed Glands, and be retain'd in it till it is accumulated in such a Quantity and Proportion as to be capable of dissolving the viscid, cohering, obstructing Matter, and pushing or driving it forwards into the larger and more open Vessels.

THO a greater Quantity of Mercury therefore in a given time will pass thro' the open and unobstructed Glands, yet in a longer time a greater Quantity will be retain'd and accumulated in the obstructed Glands, till the great Quantity of the retain'd Mercury, partly by its rarefying expansive Force destroying the corpuscular Attraction and dissolving the viscid Cohesion, and partly by its greater projectile Force, cleanses and throws out the obstructing Matter from the Glands and small Vessels into the large and more open Canals, where it is disposed and prepar'd to be carry'd off thro' the several Emunctories by the natural Evacuations.

4. WHEN a Substance of such Force and Efficacy as Mercury, is thrown suddenly, in great quantitys, and with violence, upon any of the Glands, it must needs be extremely hurtful and mischievous: for in this case the sudden Rarefaction, expansive Force, and violent Efforts of the Mercury, rous'd and excited

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into Action by the natural Heat, must overstretch the nervous motive *Fibrillæ*, suspend their Action, and quite break, dissolve, and destroy the natural Structure and Conformation of the Parts ; and the Structure and Organization of the Solids being thus broken and destroy'd, the Fluids must stagnate, corrupt and putrefy in the Organs, and the Obstructions become inveterate and incurable.

HENCE it is that they who have been too severely treated with Mercury in the *Lues Venerea*, are very often made more deplorable Victims to the Fury of the Medicine than to that of the Disease ; and a Distemper which scarce deserves a Cure, is render'd incapable of any. I know that the unhappy in this case are generally impatient of Delay, and eager for a speedy Cure ; but the Event seldom answers their Expectations, and a little present hasty Relief is for the most part follow'd with a long train of hopeless and remediless Evils, which might have been prevented by a more rational and deliberate Method.

5. THE mildest Preparations of Mercury, and such as will not salivate at all, as *Æthiops Mineral*, *Cinnabar*, or the like, when given too fast, or in too great Quantities, are often attended with very bad Consequences, as loss of Appetite, violent Cholicks, *Diarrhæas*, Erosions of the Stomach, Intestines, &c. and all these ill Consequences are still more dangerous from its stronger Preparations, when given after the same manner ; for by this means all  
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the salutary beneficial Effects of the Mercury upon the remote Glands are eluded and prevented, while an otherwise most excellent Medicine is converted into a Poison. And tho Cures may be sometimes wrought by great violence in strong Constitutions, yet whoever considers the prodigious Force of this Medicine, will, I am persuaded, think it most reasonable to go gently to work with it, and give it more time.

6. IT often happens, that too large Quantities of the Lymph or Serum being long retain'd in the Lymphaticks and common Receptacles of the Glands, the Organs by such an over-stretch and tensify lose their Elasticity and restitutive Force, and consequently become loose and flabby; from whence the Communication of such stagnating Lymph with the other circulating Lymph being suspended and cut off, the Organ will be obstructed. Under such a Circumstance, the retain'd stagnating Lymph will in the first place by Rarefaction and Fermentation throw off its most volatile, soft, and balsamick oily Salt; and retaining only its ponderous resinous Oil and fix'd Salt, it must hereby become sharp, acrimonious and corrosive: and this sharp, corrosive and extremely penetrating Serum, by vellicating the nervous Coats of the Vessels, eroding and eating off the Ligaments and Bandages of the Joints and Tendons, and piercing thro', and soaking, corrupting and mortifying the very Bones, must induce the worst De-

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grees and Symptoms of the Scurvy, and produce various Phænomena or Appearances, according to the principal Parts and Organs chiefly affected, as explain'd and exemplify'd *Prop. 13. Part II.* Now in this case Mercury is the great Specifick, Sweetner, and powerful Corrector of any such sharp, corrosive Acidities: for by opening the obstructed Canals, and procuring a Communication with the circulating natural Lymph, that which had before contracted a corrosive Acrimony, by stagnating and fermenting in the Glands, will be again replenish'd and saturated with the soft balsamick Oil of the natural Lymph. And from hence it is that Mercury is so effectual in taking off, or qualifying the Acidities of the Glands, and correcting the Malignity of all sorts of foul, eroding and fistulating Ulcers.

7. FROM this account of Mercury, 'tis evident that its great and principal Efficacy consists in dissolving, attenuating and cleansing off any viscid Concretions of Matter which may have been lodg'd upon the Glands, or their several Strainers, conveying Pipes, and common Receptacles. But the Matter thus clear'd and thrown off from the minute obstructed *Tubuli* and glandular Recesses, may not afterwards be sufficiently discharged and cast out by the natural Evacuations. Now in this case the Stomach is for the most part the first and greatest Sufferer: for any corrupt vitiated Serum, which had been stagnating, concreting and putrefying in the Glands, being dissolv'd  
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and attenuated by the Mercury, and thrown out into the larger and more open Vessels; if Nature does not find out a quick and speedy Discharge for it by some of the regular Evacuations, it will be soon thrown upon the Stomach, and affect that Organ with such an Irritation, *Stimulus* and Loathing, as to give the Physician a plain and natural Indication for the usefulness and necessity of Vomiting: by which means the corrupt, stagnating, obstructing Matter, having been attenuated, dissolved and thrown out of the Glands into the larger Vessels, may now be most safely and effectually drawn off, and cast out of the Body. And I may venture to pronounce, that in all the Species and Appearances of the Scurvy, as explain'd *Prop. 13. Part II.* this Method will be ever found most safe and successful.

IN any Course of Mercurials, Diureticks likewise are of great service. 'Tis well known to the Physicians, that there are many Diseases, the corrupt *Stamina* and glandular Lodgments of which are best and most effectually carry'd off by the urinary Discharges. And indeed where this Secretion succeeds right, there is seldom need of any other: for by this means the Stomach being kept clear and free, there will be no great necessity for Vomiting, which otherwise ought not to be dispens'd with, unless some peculiar Symptoms or Appearances forbid it.

8. THE various Effects of Mercury, and its several curative Intentions, are very much pro-

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promoted, and differently determin'd by the four following Simples; namely, *Guaiaicum*, Roots of wild Valerian, black Hellebore, and Rhubarb: of which it may be observ'd, that the two former, that is, the *Guaiaicum* and wild Valerian, have a peculiar Efficacy in throwing the Matter of any glandular Disease outward, and terminating it upon the cutaneous Glands; where it is much better manag'd than when it falls inwards upon the Stomach, Intestines, and glandular Organs of the Abdomen. On the other hand, the black Hellebore and Rhubarb have a particular Efficacy in precipitating the Matter of any glandular Disease downward, and carrying it off thro' the urinary Discharges. But this may be especially remark'd concerning the black Hellebore, that where it is mix'd or compounded with the Gum *Guaiaicum*, wild Valerian, or any thing else of a like warm and effluent Nature, it serves to promote Perspiration, or a Discharge thro' the cutaneous Glands, more than any thing else that I have ever met with. I have mention'd the *Guaiaicum* and wild Valerian to the Purpose afore-said; tho indeed the *Serpentaria Virginiana* and Saffron, are more quick and powerful to the same Intention; that is, their Effects are the more sensible, and are therefore in some cases preferable to the other, as will afterwards appear. But the *Guaiaicum* and wild Valerian have in this case something *specifick*, if I may so speak; or, which is the same thing, and all that I mean by it, they have a peculiar Efficacy

Efficacy in dissolving, attenuating and throwing outwardly the Matter of glandular Diseases.

IF any one should demand the Reason of this, I must own that I know nothing of it but from Experience, which plainly evinces the Matter to be so in fact; and this is perhaps the only Reason that can be given for the peculiar characteristick Effects of the Bark, Opium, or any other medicinal Simple.

#### SCHOLIUM I.

I DESIRE it may be here observ'd, that what I have said of Mercury as one of the most effectual and powerful Deobstruents, is to be understood as abstracted from Salivation, or any such way of giving it, as to promote any great, sensible, or violent Evacuation. For where Mercury is thus given, it must needs break, dissolve and destroy the natural Texture and Constitution of the Solids and glandular Organs, upon which it happens to be precipitated and thrown with such Violence: and the elastick motive *Fibrillæ* having thus lost their natural Force and proper Action, any Lodgment of viscid obstructing Matter upon such Glands for the future, must be fix'd there without Remedy, and the Obstruction become incurable. And hence it is, that they who have been injudiciously treated with Mercury, by too strong and violent Salivations, are often reduced to the most deplorable Circumstances, and put out of all the hopes and possibility of a Cure by any other Method. I

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I KNOW it will be urg'd by some, that Salivation in a high degree is necessary to the cure of the Venereal Disease, where it is once strongly or deeply fix'd. But such is my Incredulity and Diffidence, that I am very apt to question the truth of this in Fact; and I only desire those who have any great Experience in this case, to tell us faithfully whether they have ever known a good Cure wrought by a high Salivation upon such as have been much afflicted with hypochondriacal or hysterical Disorders; and whether the Success has not fail'd in proportion to the strength of the Salivation, and the Over-stretch of the obstructed convulsed Glands. But this I think is certain, that the greater the Obstruction of the Glands is, and the more they are tumefy'd, distended and stimulated, the less capable will they be of any violently impress'd Force of Mercury, and the more necessary will it be to do the work with more Moderation and in longer time.

### SCHOLIUM II.

SINCE Mercury is the greatest and most powerful Deobstruent, by this Proposition; and since Fevers arise from an Obstruction of the Lymphatics and chyloferous Ducts, by *Prop. 14. Part II.* it may perhaps be here demanded, How it comes about that Mercury is not the most effectual Remedy in Fevers, where however it is not trusted, and has never been observ'd to have any considerable good Effects?

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In answer to which, it may be observ'd, that Mercury as a Deobstruent has its principal Effect upon the most fix'd, obstinate and concreted Obstructions of the Glands, and such as require some considerable Time for their Attenuation, Dissolution and Discussion. And therefore in all chronick glandular Diseases, in which the heat and viscidty of the Blood come not up to a direct and proper Fever, Mercury, under the Limitations and Restrictions already mention'd, is the only certain effectual Deobstruent that I know of in the World: but in Fevers, especially such as are acute, the nature of the Obstruction is very different, and requires such a deobstruent Method as may be capable of diluting the Fluids, stimulating the Solids, and recovering the Circulation of the obstructed Lymph in a short time; without any such Violence as must be the necessary consequence of giving Mercury in large Quantities, so as to produce any great and sudden Effects. When the lymphatick Drain is suspended in an acute Fever, something or other must be quickly done to restore the obstructed Circulation, or else the only time will be lost in which the Patient is capable of being reliev'd. Mercury therefore in this case is not a proper Deobstruent, because it cannot be given fast enough and in sufficient Quantities, without great danger. Nothing, 'tis plain, could be of worse consequence in Fevers, than throwing the Blood and Humors suddenly and with violence upon the Head, which yet

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must be the Result of giving Mercury in large Doses ; and if it should be given but slowly and gradually, the Fever would destroy the Patient before the Deobstruent could have its Effect.

IN this case therefore, there is need of some other Deobstruent or glandular Cathartick, which by its attenuating and stimulating Propertys may be capable of cleansing the Glands, and recovering the Circulation of the Lymph in a short time, and without any ill Consequence. And such a lymphatick Deobstruent, or glandular Cathartick in Fevers, is Cantharides, as apply'd in Epispasticks: after what manner they operate, and how wonderfully they cool and dilute the Blood, by procuring a speedy and safe circulation of the obstructed Lymph, has been sufficiently explain'd already at *Prop. 14 and 15. Part II.*

### PROPOSITION III.

*TO retain the Æquilibrium of the circulating Blood, against the frequent occasional Affluxes and Reflexes of the vital Fluid.*

FROM what particular Occasions, and by what sort of Mechanism this *Æquilibrium* of the Blood may be broken or interrupted, I have largely enough consider'd and explain'd in several of the foregoing Propositions. It remains here therefore only to consider the medical Operation, how this different Direction and Determination of the resluent Blood, may  
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be turned one way or the other as Occasion serves, in order to recover and retain the *Æquilibrium*.

THE general Intention of raising and diffusing the vital Fluid, as abstracted from all other Symptoms, is best obtain'd by the *Serpentaria Virginiana*, and Saffron. Opium has likewise a very great Force and Efficacy this way: but in all great and obstinate Obstructions of any of the principal Organs, Opiates are to be sparingly and cautiously used, with the Regulations and Restrictions already laid down, *Prop.* 17, 18. *Part II.*

THE contrary Intention of depressing and repelling the Blood, (when it happens to be raised and diffused with a too great Force and Impetus) may be easily obtain'd from the *Testacea*, Sal Prunel, Rhubarb, and all cooling diluting Liquors. Bleeding also and Glisters are very efficacious to the same Intention; but the former ought to be directed with greater Nicety and Care than is commonly imagin'd. Acids likewise of all sorts; as Juice of Lemons, Spirit of Sulphur, &c. in Juleps and Draughts, serve very well to cool, condense, and repel the over-heated effluent Blood.

BUT I cannot here forbear mentioning and doing justice to one thing, which perhaps may be despis'd because it is too common; I mean Apples, especially the gratefully acid and oily sort, such as the Kentish Pippin, Pearmain, Pomeroy, Nonparelle, &c. these are mode-

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rately cooling, diluting, attenuating, cleansing and balsamick; they condense and precipitate the Matter of a too hot and flatulent Digestion, cool and refresh the Stomach and Bowels, attenuate and propel the *Fæces*, and promote a most natural and benign Evacuation by Stool. In short, under all hot, flatulent and rarefactive Disorders of the Chyle, Lymph and Blood, they are an excellent Stomachick, Pectoral and Diuretick.

WHEN the Blood in this interrupted *Æquilibrium* is various and differently determin'd, sometimes one way and sometimes the other, the Simples under each Intention must be accordingly mix'd and variously compounded; of which the Physician will be only capable of judging by a careful Consideration of the Symptoms and present Appearances.

### PROPOSITION IV.

*TO recover and maintain an equal or due Proportion of the Crassamentum and Serum in the Blood.*

'TIS manifest, that either the one or the other of these, the *Crassamentum* or the Serum, may abound in a too great Quantity and Proportion with respect to the other; or, which is the same thing, the *Crassamentum* may bear a too large or a too small Proportion to the Serum.

BY indulging the too free and plentiful use of such Meats and Drinks as abound with rich Oils,

*in the Cure of Diseases.* 433

Oils, Sulphurs and volatile Salts, the quantity of the *Craffamentum* is immoderately augmented; and this occasions a hot flatulent Digestion, and disposes to all such Diseases as proceed from Heat, *Flatus*, and Rarefaction: and what these are, and with what different Symptoms and Appearances attended, has been consider'd already.

HERE therefore, the best Method of Cure is to take away the Cause; that is, to live soberly and temperately, to feed sparingly on Flesh well boil'd or roasted, with plenty of Garden-stuff; to forbear all Excess in hot, spirituous, fermented Liquors; and to use a cooling diluting Method, by drinking Water, green Tea, eating Water-gruel, Milk-porridge, Milk and Apples, &c. especially in the Morning: for this may be taken as a certain Rule, that the Morning is the proper Season for diluting, and the Evening for chearing, invigorating, and raising the animal Constitution, if need be, after the labour and fatigues of the Day.

THERE is another Method of lessening the *Craffamentum*, where it too much abounds in quantity with respect to the Serum; and that is by frequently repeated Bleeding in small or moderate Quantities. For the *Craffamentum* being a standing Quantity like the Flesh or Fat, tho this part in Bleeding is drawn off proportionally with the Serum, yet it will not be recovered, or increased afterwards in the same time; and therefore

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by frequent Bleeding the quantity of the *Crassamentum* will be diminish'd, and that of the Serum proportionally increased. But this necessary Caution must be observed with respect to Bleeding, as the means of lessening the *Crassamentum*, that such an Intention cannot possibly be obtain'd by it, where the Lymphaticks are torn and dilacerated in a Dropsy, so as to let out their Serum into the Cavities of the Body. In this case, while the Serum is continually running off thro' the broken Lymphaticks, the *Crassamentum* must needs abound in the Blood-Vessels, there being little else left: but here tho the Proportion of *Crassamentum* to the Serum is too great, yet the absolute Quantity of the Blood is exceedingly diminish'd, by the continual Drain of Lymph into the Cavities of the Breast and Abdomen. And therefore 'tis plain that Bleeding in this case can be of no service, but on the contrary must be extremely hurtful and mischievous.

WHAT has been here said of a Dropsy, may be equally understood of any immoderate Evacuation, in which the Serum being thrown off too fast, the proportion of the *Crassamentum* will be too great while the quantity of Blood is diminish'd: in all which cases Bleeding must be very prejudicial, and the only true method of Cure will consist in stopping or restraining the preternatural Evacuations.

By a too cold and slow, or a too quick, precipitated, and scorbutick Digestion, the Proportion of the *Crassamentum* to the Serum will

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be preternaturally diminish'd, while the Blood in its absolute Quantity continues the same. In this case, to restore the natural Proportion of these two Principles in the Blood, the Error of Concoction must be corrected, which arises either from a Defect of the natural digestive Heat, or from a scorbutick Taint fix'd upon the Stomach, or from both these variously mix'd and join'd together : in both which the Method of Cure may be easily collected from *Prop. 16. Part II.* concerning Digestion.

PROPOSITION V.

*TO strengthen and keep up the elastick Tone, or muscular Force of the Nerves.*

THE nervous elastick *Fibrillæ* are subject to two contrary Indispositions, or morbifick Constitutions : for either they may be stiffen'd, harden'd and contracted, so as not to be capable of stretching by any ordinary Force or stretching Power ; or, on the other hand, these motive elastick Fibres may be stretch'd and relax'd beyond their natural Tone, or capacity of Restitution and Contraction.

Now 'tis well known, that any elastick Thread or Fibre, by being over-dry'd, whether by Heat or Cold, will become stiff, hard and inflexible ; upon which it will immoderately contract, so as to lose its capacity of being stretch'd and distended. But on the contrary, any such elastick String being over-soak'd and drench'd in Water or other such-like Fluid,

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will become soft, lax and flabby ; and in this case it may be easily stretch'd, or drawn out by a small Force, but will be incapable of recovering, or contracting itself again, when that stretching Force is taken off.

THIS is plainly matter of Fact and Experience ; and from hence it must follow, that these two contrary States, or morbidick Dispositions of the Nerves, are owing respectively to the too great driness, and moisture of the Constitution: and from this Consideration, the true and natural Indications of Cure, either in the one or the other, may be easily understood and apply'd in Practice. The soft, lax and flabby State and Constitution of the Nerves, is brought on by all the Methods of Luxury, Excess, and indulged Rest or Inaction; from whence the Fluids contract a Viscidity, and are immoderately accumulated, and heap'd up upon the over-stretch'd, distended and obstructed Glands ; by which is induced a weak, feeble and enervated Constitution. This is likewise the natural State and Disposition of Children, in whom the Fluids bear a great Proportion to the Solids ; and Women are, *cæteris paribus*, more liable to it than Men. The contrary state of Stiffness, Rigidity, and Inflexibility of the Nerves and motive *Fibrillæ*, is brought on by excessive Exercise and great Fatigues, immoderate Watching, too great Evacuations; and by all the drying emaciating Passions, as Anger, Revenge, Envy, Malice, Madness, and excessive Desire in every thing.

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THIS is likewise the natural Disease of old Age; in which the motive *Fibrillæ* and Coats of the Blood-Vessels, gradually contract a Stiffness, Rigidity and Driness; the Cartilages indurate, and grow as hard as Bones; and the softer Coats, Ligaments, and Membranes become cartilaginous.

IT may be here observ'd, that Water, which is the common Vehicle of all our Food and Nourishment, is more or less stock'd with Sand, Gravel, Chalk and other stony and fabulous Matter, which being convey'd into the Blood, and there attracted and retain'd by the Solids, they are at long run exceeding apt to petrify; and when this Petrification happens upon any of the principal Organs, especially upon the Valves of any of the great Blood-Vessels, it necessarily destroys their natural Use and organick Action, and renders any such Disease absolutely incurable. It is therefore perhaps happy for those who before they are thus affected, are in good time blest'd with the Gout; by which that fabulous Matter which is retain'd in the Blood, not passing off as it ought thro' the urinary Drains, is derived plentifully to the extreme Parts of the Body, and the more necessary or vital Organs hereby guarded and secur'd. From what has been here observed of the Causes, the curative Intentions, or the Method of securing the Nerves against these two opposite Evils, will be easily understood by such as have a Genius for this Study; and they who have not, would not be much the better for a larger Explication.

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## PROPOSITION VI.

*TO promote and keep up the natural Evacuation or Secretion by Urine.*

FROM what has been said *Prop. 13. Part II.* it is evident, that this Intention is of the utmost Importance to Health and long Life; that most chronick Diseases are owing to the want of a due and regular Secretion by Urine; and consequently, that a numerous Train of severe Evils may be prevented by a just Regard to this necessary Discharge. Now the obtaining this Intention, will depend upon considering duly the different State and Circumstances of the general Case. For,

1. As to those who have indulg'd a Method of hot Intemperance, till they have over-rais'd and heated the Blood, and contracted a flatulent Digestion; the most effectual Diureticks to them will be Water, green Tea, Apples, Milk and Apples, or a thin Emulsion made of the Pulp of roasted Apples, with any cooling diluting Liquor; especially if such a Method be constantly taken in the Morning, which will be the most effectual way to throw off and discharge any such viscid Lodgments upon the urinary Glands, as had been contracted and accumulated during the time of Sleep.

2. IN cold, low and languid Constitutions, where the Secretion is lessen'd from a diminish'd Velocity of the Blood, Infusions of Horse-radish, Mustard and Gromwell-Seeds, Mille-

Millepedes, a few Drops of the Balsam of *Cappivi*, and such warm stimulating Diureticks mix'd with Diluters, will be most effectual.

3. WHEN the urinary Glands are very much stuff'd and loaded with Gravel, or any fabulous Matter which cannot be thrown off by the common Diureticks, recourse must be had to Cantharides; which given in small Quantities, not exceeding five Grains, and well diluted with any thin, soft and milky Liquor, is beyond all dispute the most powerful and effectual Diuretick in the World.

4. WHEN the urinary Glands and Passages are scorbutically affected, dilacerated and eroded, the curative Intention cannot be obtain'd without Mercurials; the Nature and Use of which has been already explain'd.

5. BUT the greatest difficulty of obtaining this Intention is in Dropsys; where the great and general Stretch or Distension of the Lymphatics and Glands thro'out the whole Body often eludes the Force of all possible Diureticks. In this case the best and most effectual Method of drawing off the Waters, is by Blistering; keeping some one or more of them continually running in several Parts of the Body, till the Water is discharg'd, which by this means will be effected in a short time to a wonder; and then any of the common Diureticks will take place, unless the Lymphatics are broke, so as to let out the Water into the large Cavities of the Thorax and Abdomen; and then the Disease may be look'd upon as desperate, and will admit of no Cure.

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I KNOW that Purging in Dropsys, even with great Violence, is generally indulg'd, and by this means the Waters are often drawn off: but hereby the Stomach, Intestines, and glandular Organs of the Abdomen are frequently weaken'd, and over-stretch'd to such a degree, that the Waters soon collect again, in spite of all that can be done to corroborate and strengthen the Organs. And therefore where Diureticks in a Dropsy will not take place at first, 'tis certainly the best way to proceed directly to Blistering; by which a Discharge may be made, without weakening and farther stretching the Organs. And such is the Safety and great Advantage of this Method, upon several Accounts, which I cannot now stay to enumerate, that I think nothing ought to set it aside for any other, but the Obstinacy and immoveable Resolution of the Patient, who may have sometimes such an unreasonable Averſion to Blistering, as to be absolutely unperſuadable in this caſe.

*F I N I S.*





Fig: 1.

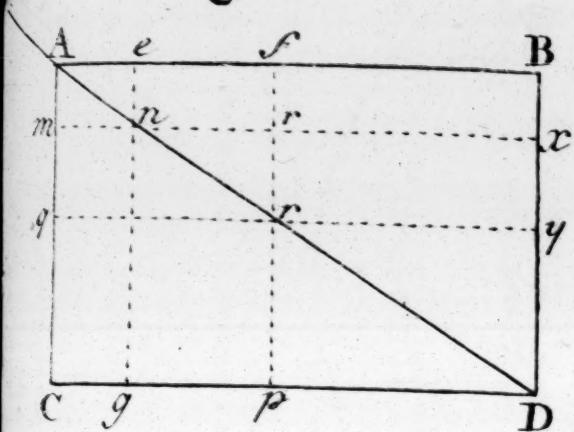


Fig: 3

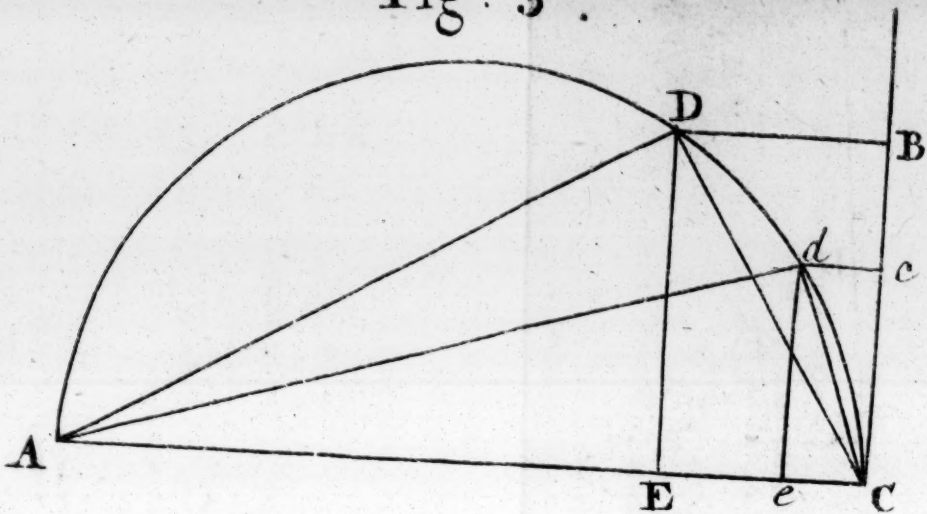


Fig: 2.

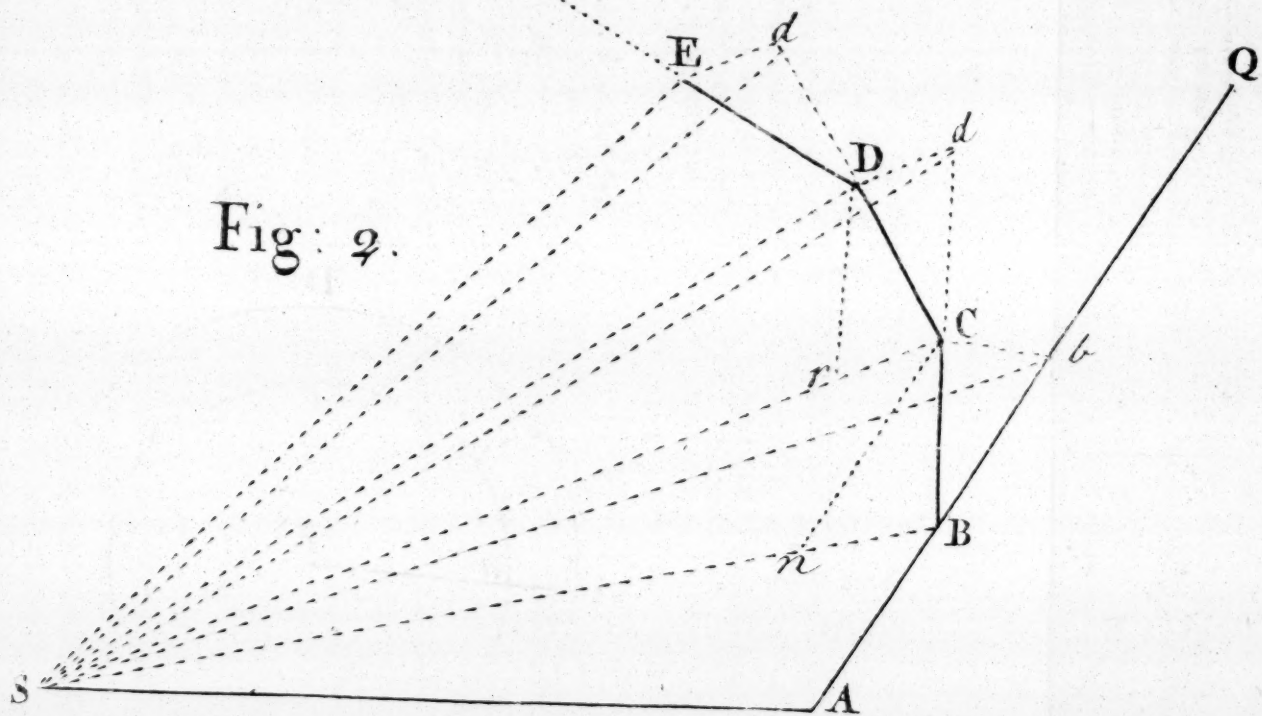


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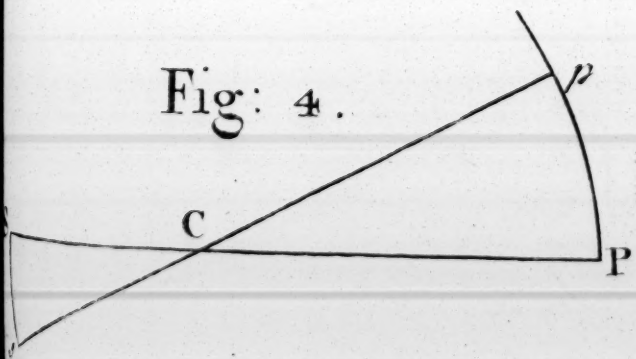


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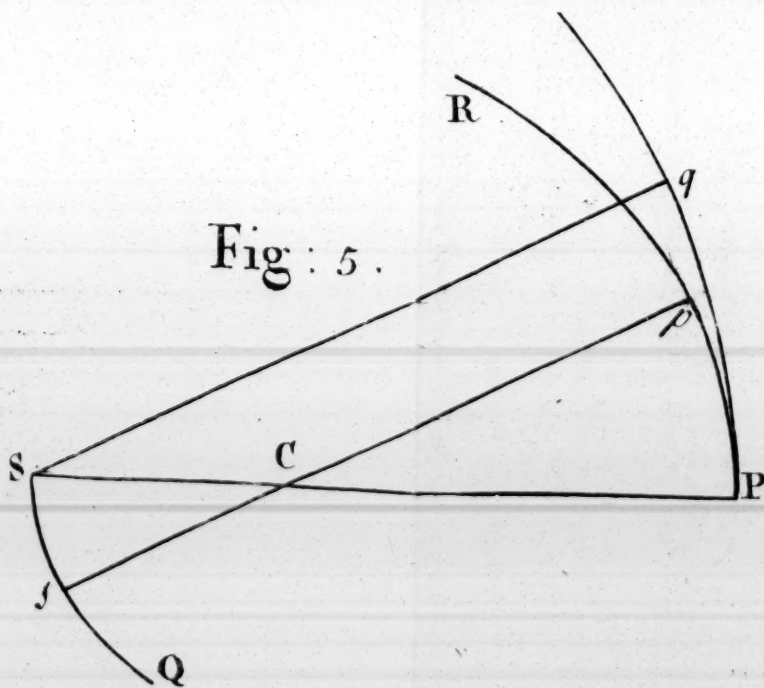


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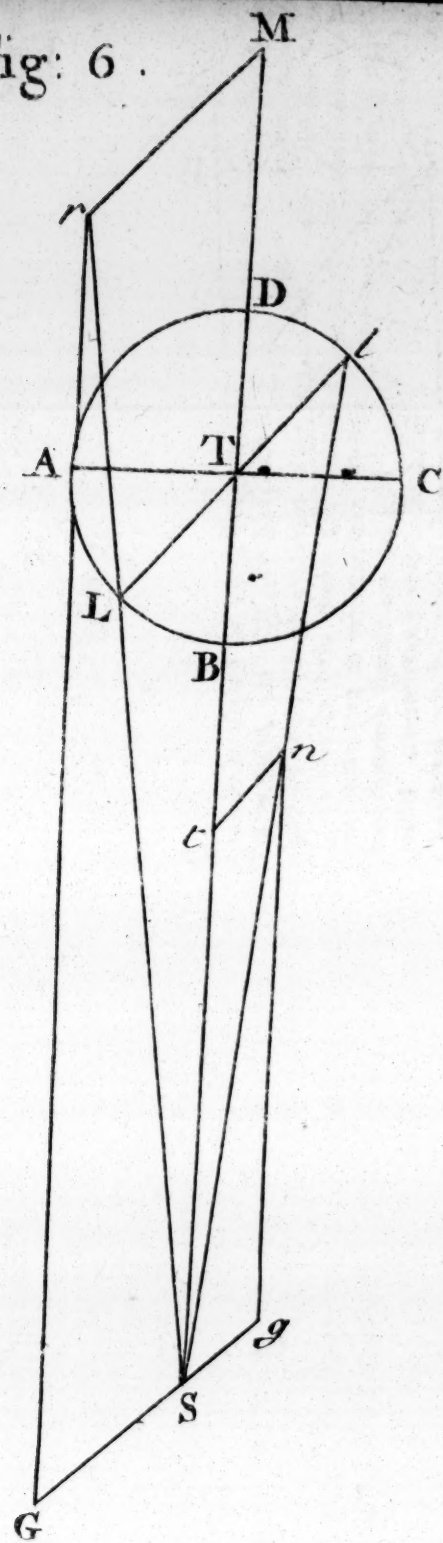


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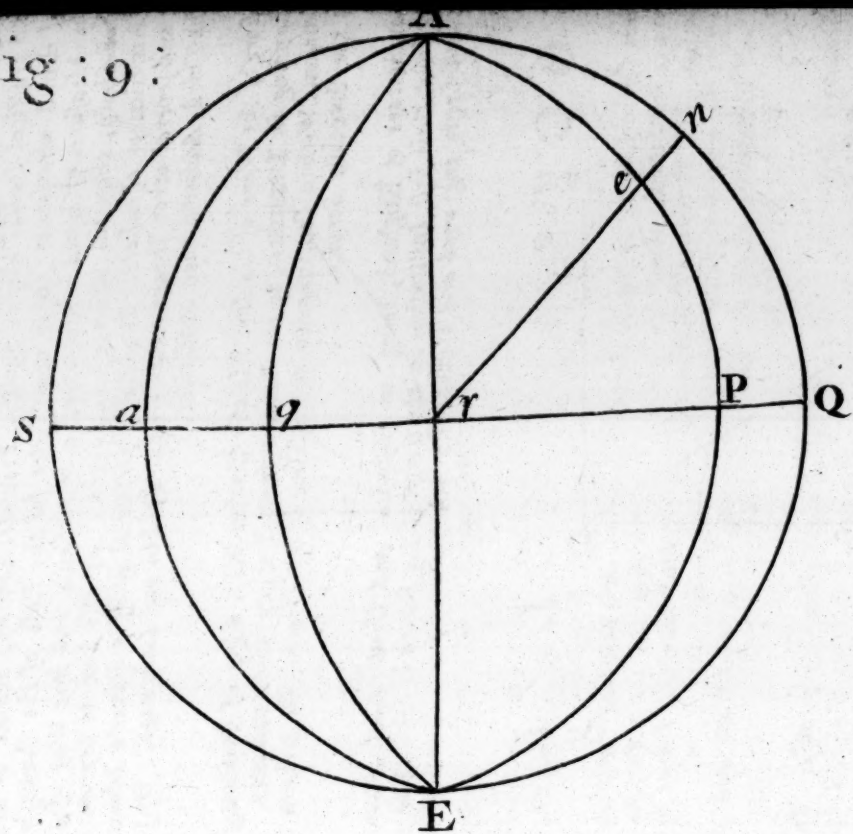


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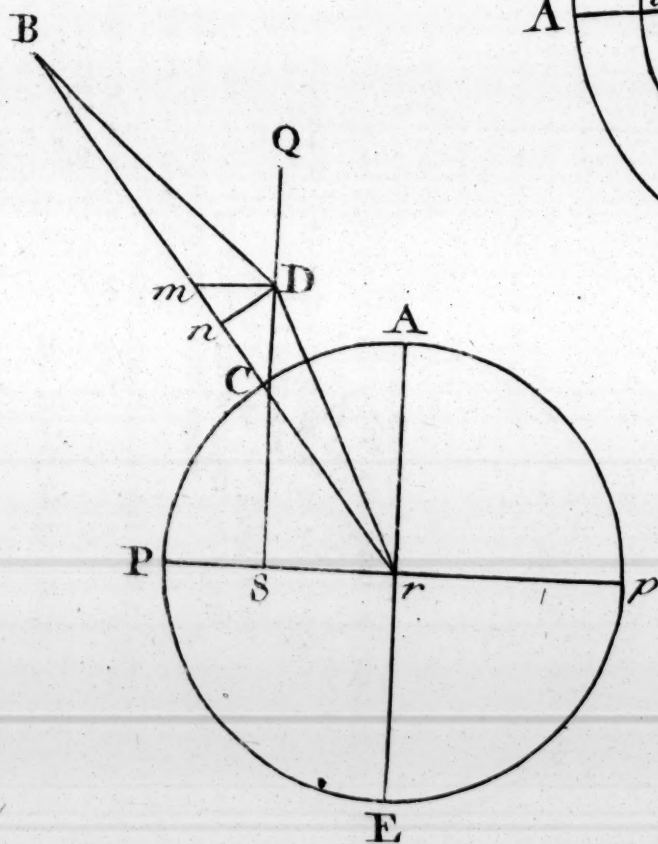
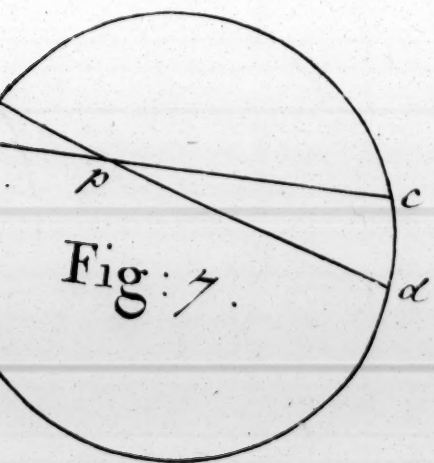
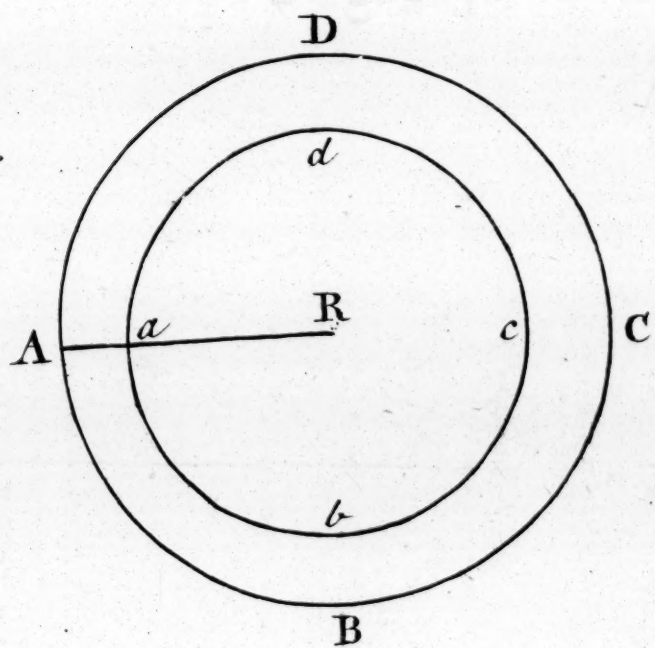


Fig: 10.